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PRACTICAL ELECTRONICS

PE VOL 24 NO 4 APRIL 1988

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TEACHER COUNTER by Tim Pike 40
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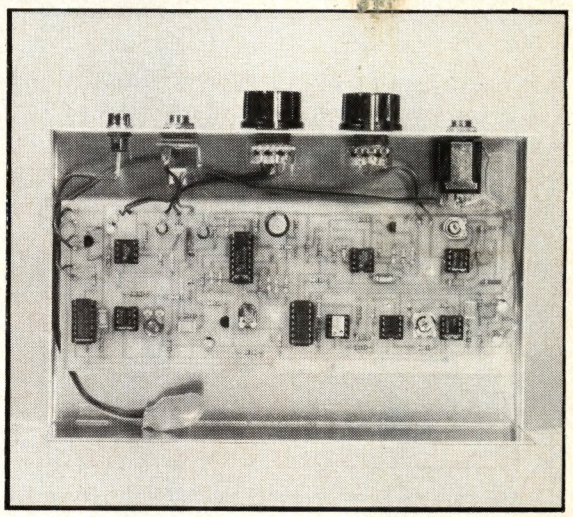

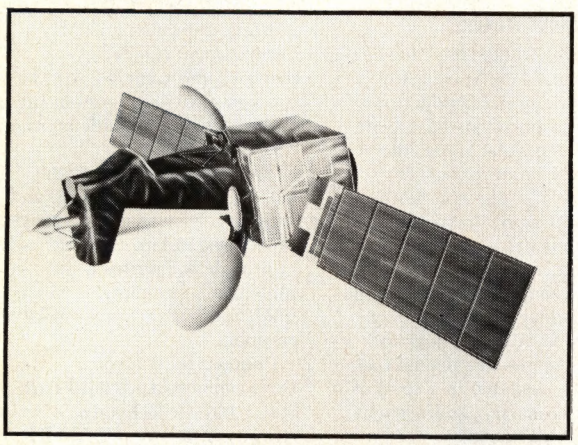

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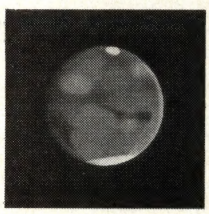

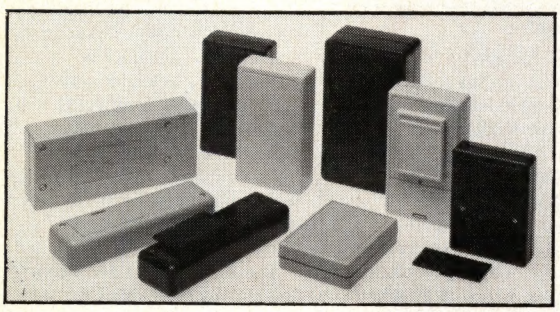

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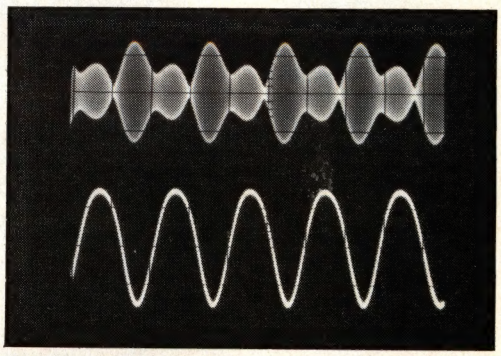
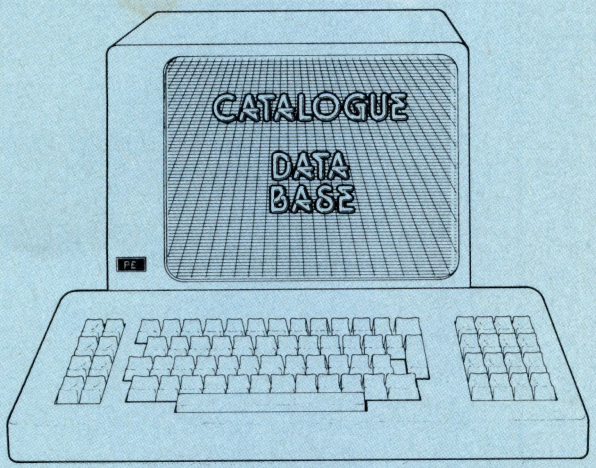
NEXT MONTH . . .

SPRING HAS SPRUNG AND SO HAVE WE TO BRING YOU – MAINS MODEM • SPEECH PROCESSING • INTELSAT VI AND BEYOND • DAT – THE REALITIES • MOSFET APPLICATIONS • CONSUMER ELECTRONICS REPORT • AND OTHER TOP LINE FEATURES WILL BLOSSOM FORTH•

DON'T LET THE GRASS GROW UNDER YOUR FEET BY MISSING THE PE MAY 1988 ISSUE ON SALE FROM FRIDAY APRIL 8TH



THE SCIENCE MAGAZINE FOR SERIOUS ELECTRONICS ENTHUSIASTS



We have recently received the following catalogues and literature:

Sansui, who are a subsidiary of the Hi Fi Markets Group, have issued a booklet, *'The Sansui Collection'*, detailing their **consumer audio-video products.** These include amplifiers, tuners, equalisers, cd players, cassette decks, speakers, turntables, and a range of video equipment. **Sansui Electronics UK Ltd,** Axis 4, Rhodes Way, Watford, Herts, WD2 4YW. 0923 228584.

Versactec have published a new free brochure called *'Electrostatic Plotting – the choice in wide format graphics output'*. Its intention is to help users select the most suitable **electrostatic printer-plotter** by providing information on colour and monochrome plotting widths. **Versatec Electronics Ltd,** 5 Oxford Road, Newbury, Berks, RG13 1QD. 0635 517200.

Audiokits have announced their most comprehensive component notes and catalogue of **audio quality capacitors for constructors,** service engineers and audio manufacturers. Coded ACN12, the notes are available free to the trade, but are priced at £4 (incl post) to non-trade constructors. **Audiokits Precision Components,** 6 Mill Close, Borrowash, Derby, DE7 3GU. 0332 674929.

Volex have released a colourful promotional brochure outlining their product **range of electrical accessories,** including plugs, sockets, cables and wiring harnesses. Their products appear to be more relevent to the trade, but anyone interested should contact **Volex Group plc,** Volex House, Lissadel Street, Salford, M6 6AP. 061 736 5822.

STC's 8-page full colour brochure outlines the **widest selection of cells and batteries** offered by any electronics distributor in the UK. It is available from The Battery Group, **STC Electronic Services,** Edinburgh Way, Harlow Essex, CM20 2DF. 0279 626777.

EXCLUSIVE!
IN THE NEXT ISSUE OF PE

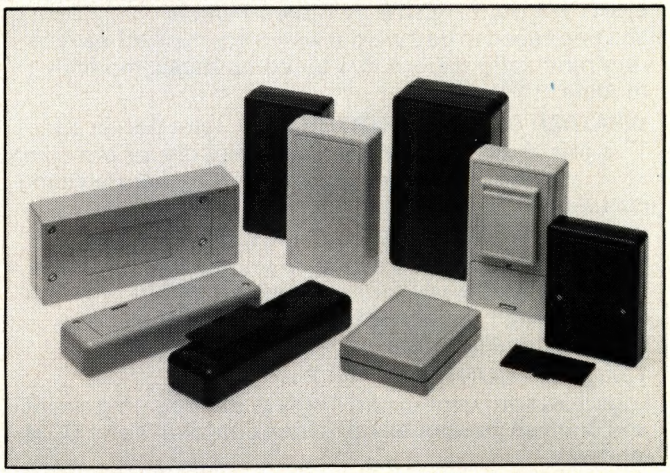
LATEST on the US Electronics and Technology scene with a special report from

THE CONSUMER ELECTRONICS SHOW IN LAS VEGAS
BY DR WAYNE GREEN

Well known US Author, Publisher (Founder of over 50 Computer Technology Magazines including *Byte, MicroComputing,* and *73*) and currently Vice-Presidential Candidate.

READ IT IN THE MAY ISSUE!

WHAT'S NEW



Hand Held Boxes

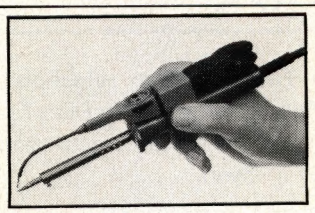
Two electronic case ranges, designed exclusively for development and production of hand-held portables have been launched by West Hyde, the Aylesbury based enclosures company. The growing market for pocket sized, hand-held equipment has led to the development of two extremely versatile ranges from one of the UK's leading enclosures companies. Named Tinos and Elos, these low-cost (from £1.44) cases are available in a total of nine different sizes and in a light grey and black abs.

The Tinos range have on one side a textured finish to provide a firmer grip, also a battery compartment for PP3 9V batteries and rounded corners throughout. One model in the range even has a moulded pocket clip.

The Elos, while being the more general purpose range and without a battery compartment, carries as standard moulded pads to provide a base for a pcb and sub-chassis mounting.

All case sizes are now available ex-stock.

Contact: West Hyde Developments Ltd, 9–10 Park Street Industrial Estate, Aylesbury, Bucks, HP20 1ET. Tel: (0296) 20441.



Solder Feeder

Tele-Production Tools Ltd, the Westcliff-on-Sea soldering specialists are now marketing a new Swedish solder feeder device.

The feeder can be attached to any pencil iron and the feed tube adjusted to ensure that the solder is fed directly on to the soldering tip. Solder is wound on to a cassette, which is attached to the reverse end of the device, and is then fed by advancing a knurled wheel with the index finger. It is suitable for left or right hand use.

The solder feeder is a useful third hand when objects have to be held in position while soldering; it also alleviates problems caused by operators continually handling high lead content solder. The price is £10 plus VAT.

Contact: Tele-Production Tools Ltd, Stiron House, Electric Avenue, Westcliff-on-Sea, Essex SS0 9NW. Tel: 0702 352719.

Big Brother Speaks

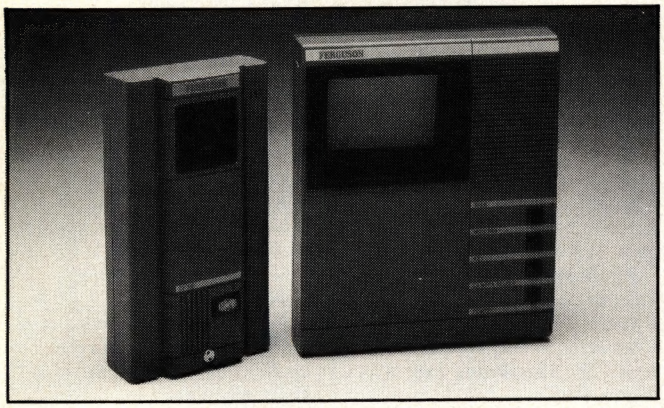
November the 5th 1987 saw the launch of a new addition to the JBL Control Series loudspeaker range. The Control 5 is the new big brother to the well established Control One system that has been massively successful in many market areas.

The JBL Control 5 is immediately available and measures a very compact 15 × 10 × 9 inches. It is capable of handling 175W with usable output down to 50Hz. With this power handling, each Control 5 can generate over 114dB SPL (1m).

The drive units have been specifically developed for this project. The HF is a pure titanium driver which has added protection built into the dividing network to minimise damage caused by overdriving and errant amplification. The bass driver has been designed for low distortion performance even at very high levels.

The Control Five is designed with ease and flexibility of installation as a primary feature, and a pair of them cost just £279 including VAT.

Contact: Harman (Audio) UK Ltd, Mill Street, Slough, Berks SL2 5DD. Tel: 0753 76911.



Homescanner

Ferguson are launching two new products to help protect you and your home under their Homescan banner.

Increasingly, the public is concerned about that which Crime Prevention Officers call "Access Control", that is, monitoring exactly who comes into the home and why. Security consciousness is on the increase – and this is welcomed by the authorities. In the last six years consumer spending on security has rinse from £84 million to £175 million.

Ferguson is introducing two access control systems, both of which can be easily installed, in a couple of hours, by anyone competent in diy.

One system, the FHS1 comprises a video camera and control unit, which are capable of operating in total darkness.

The camera is mounted by the front door and the picture of the caller is fed through to a designated channel on a domestic television which gives one-way audio visual communication. By wiring the control through the doorbell system, an audible alarm will interrupt any tv programme being watched to inform the viewer to switch to the appropriate channel to see and hear the caller.

The other system, the FHS2, comprises a video camera mounted in a unit including a bell push, microphone and speaker, and a separate dedicated video monitor/control unit, both with wall-mount brackets. Once again, the camera can work in total darkness and also offers two-way audio communication, (a useful benefit for the blind and disabled). An electric door lock can be released by pressing a button on the monitor unit after the visitor has identified himself, and a led indicator shows when the door is open, or unlocked.

Two cameras can be linked up to the video monitor to give access control at the front and back doors or one can be used indoors for baby minding.

The FHS1 costs around £449, and the FHS2 about £749.

Contact: Anne Waterman, Ferguson Ltd, Cambridge House, Great Cambridge Road, Enfield, Middx. EN1 1ND.

Digit Control

HOW would you like to be able to control ALL your heating, lighting, machinery, air conditioning, in fact anything that depends on electrical energy from one mobile control point? An expensive pipe dream? Not anymore. A new mains signalling system has been launched at a cost that should bring easy energy saving and security within the reach of even the smallest business.

The Emlux MS System, as it is called, uses state-of-the-art electronics throughout, but is designed to operate in a straightforward, uncomplicated way and brings ultra modern energy management techniques under finger tip control.

The command signals are transmitted along existing standard 240 volt supply cables which means that the costly and often inconvenient installation of dedicated wiring is avoided. In fact, installation couldn't be simpler since all that is necessary is the plugging in of the command module to a standard 13 amp socket. The most junior employee can operate the system, since the touch of a button is all that is needed to set it into motion. Inclusion of the proven Emlux patented Filter as an integral part of the system ensures that all commands generated are contained within the premises.

The basic starter pack, which comprises one console, four slave modules (2 plug-in, 2 wire-in) and one filter, sells for less than £300. Extra slaves can be supplied at about £35 each. In addition to the basic MS controller, a programmable clock controller is available to provide automatic control.

Contact: Emlux Ltd, Industrial Estate, Black Bourton Road, Carterton, Oxford, OX8 3EZ. Tel: 0993 841574.

COUNTDOWN

If you are organising any event to do with electronics, big or small, drop us a line – we shall be glad to include it here.

NOTE: Some events listed here may be trade or restricted category only. Also, we cannot guarantee information accuracy, so check details with the organisers before setting out.

Regular courses for R.A.E., and also for Morse. Grafton Radio Society, Elizabeth Garrett Anderson School, Riseing Hill Street, London N1.

Regular weekly courses for Radio Amateurs Exam (C8G 765). Tuesdays 7.30 to 9.30. Hendon College, Corner Mead, Grahame Park, Colindale, London NW8 5RA. Tel: 01-200 8300.

Mar 20. Pontefract and District Amateur Radio Society annual components fair and boot sale. Carlton Community Centre, Carlton, Pontefract. 0977 43101. (Good luck you enterprising lads! Ed.)

Mar 22-24. Internepcon Production Show and Conference, plus Electro Optics and Laser UK. National Exhibition Centre, Birmingham.

Mar 29-30. Instrumentation Harrowgate. Trade only. Harrowgate Exhibition Centre, Harrowgate, N. Yorks. 0822 4671.

Apr 12-14. Scottish Computer Show. Scottish Exhibition Centre. Glasgow.

Apr 13-14. Laboratory Cambridge. Kelsey Kerridge, Cambridge. 0799 26699.

Apr 26-28. British Electronics Week 88. Olympia. 0799 26699.

Frame Foam

Wybar Electronics have introduced cut-to-size conductive foam for its range of printed circuit board assembly holders. The foam can be supplied with new units or retrofitted to existing units enabling the safe handling of static sensitive components.

Pull spare parts, such as springs, bearings, clips and additional rails are also available from stock.

Contact: Wybar Electronics, Unit M, Portway Industrial Estate, Andover SP10 3LU. Tel: 0264 51347/8.

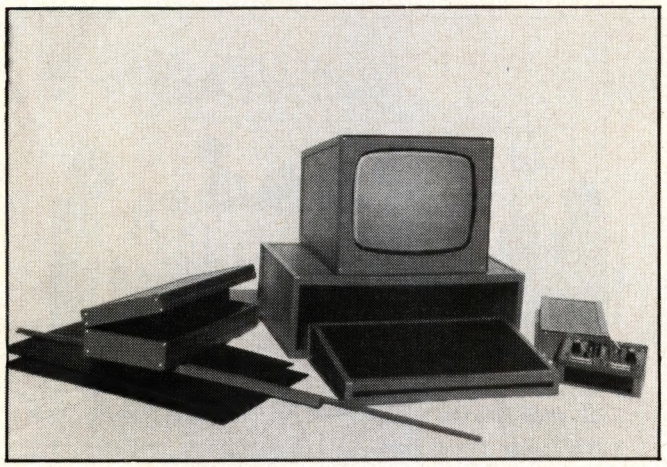
Damp Heat

Solex, the sole UK representative for the Soar range of test and measuring equipment, has recently launched the HT-150 multifunction module that measures temperature and humidity simultaneously.

The unit is ideal for panel mounting and has a high resolution, °C or °F selectable, large liquid crystal display. In addition to the basic functions, it provides a hi-lo alarm, max-min record and discomfort index display functions. Simultaneous data signal outputs of both temperature and humidity allow the unit to be used in connection with external devices such as controllers and printers.

External long probes up to 100m maximum for remote control of both humidity and temperature are available as an optional extra for various kinds of applications.

Contact: Solex International, 95 Main Street, Broughton Astley, Leicestershire LE9 6RD. Tel: 0455 283486.



Boxing Clever

Encore Enclosures are marketing an enclosure system developed as a result of a suggestion from a lecturer at Bath University for a make-it-yourself, easy-to-assemble box since one of the most difficult tasks of a student project is to find an enclosure which is inexpensive, the correct size and looks professional.

Encore supply plastic sheets and sections, together with construction details, which can be used to make any particular design. The individual pieces occupy little space, an advantage if stocked for future requirements.

The system is relatively forgiving of mistakes in construction as all the raw edges are covered up and a generous tolerance allowed for the fitting. To change the position of a misplaced cutout, at worst you only have to change one panel. The more complex the structure, the greater the financial advantages.

For the faint-hearted, or those who have more important things to do with their time, Encore now offer to build to anyone's enclosure design (even an one-off) at prices below what they would probably pay for a standard enclosure.

Contact: Encore Enclosures, Unit 3, Willand Industrial Estate, Cullompton, Devon EX15 2QW. Tel: 0884 820955.

Young Electronic Engineers Awarded

Paul Dagley-Morris (left) and Roger Lucas (right), two sixteen-year-old pupils at Cheltenham College, are seen with their animal trauma meter, which gained them and the school third place in this year's Young Engineers for Britain competition, sponsored by the National Engineering Council.

Although the trauma meter is designed for measuring shock in animals, 'patient' Dusty seems in relaxed mood here. In the centre is Vet Mike Daley, whose practice gave encouragement and support to the two young electronic engineers in the design of this device, the first of its type.

Contact: PRB Public Relations and Marketing Ltd, 3 Wolseley Terrace, Cheltenham GL50 1TH. Tel: 0242 510760.

Young Radio Amateur Awards

Anybody under the age of 18 who has made waves in the world of amateur radio should enter the Young Amateur of the Year Award now.

The award, sponsored by the Department of Trade and Industry as part of the 75th anniversary celebrations of the Radio Society of Great Britain, is designed to increase awareness of amateur radio amongst young people and highlight the skills and benefits that participation in this unique activity can bring.

The £250 prize will be awarded to the person judged to have made an individual contribution of outstanding merit (between 1 April 1987 and 31 March 1988) in any area of amateur radio. This might include technical innovation, exceptional operating skills, success in promoting amateur radio to a wider audience, the fostering of international goodwill, social work for the handicapped or emergency communications. It is hoped that the prizegiving will take place at the RSGB's national convention in July 1988.

The winner will also spend a day with the Department's Radiocommunications Division learning at first-hand about the varied work of the Department in the radio field.

The award is open to any resident (who need not be a current holder of the Amateur Radio Licence) of the UK, the Channel Islands or the Isle of Man who has not reached his or her 18th birthday by the closing date.

Applications or nominations must be sent to The Secretary, RSGB, Lambda House, Cranborne Road, Potters Bar, EN6 3JE. **The closing date is 31 March 1988.**

Bristol Maplinised

Maplin Electronics, have announced the opening of their latest shop, situated close to Bristol city centre, at 302 Gloucester Road, Telephone 0272 232014.

In formerly opening the new shop, Brian Lodge, Director of the Department of Industry South-West Region, said that many local electronic enthusiasts would welcome the arrival of a new Maplin store in Bristol, as many youngsters find positions in local companies which are heavily involved in electronics. Brian Lodge congratulated Maplin on the range of products on show together with the highly professional appearance of the store. He hoped that Maplin would continue to source as much material as possible from UK-based manufacturers. He wished all concerned every success.

Kent Cider Flows

Kent Veriflux VTC flowmeters are being used for metering cider and apple juice transfer to road tankers at Symonds' plant in Stoke Lacey. The signal output from the flowmeters is taken to a local display unit to show the quantity of cider transferred. As this can amount to approximately 25,000 litres per load, it is essential to have accurate flowmetering.

Pasteurisation in the process plant is monitored and controlled by Kent instruments, circular chart recorders and control units, while conductivity cells allow the monitoring of caustic concentrations during cleaning processes and electrodes are used in the laboratory for sample analysis.

Symonds' have been producing premium quality ciders since 1727. The plant at Stoke Lacey, Herefordshire, has been dramatically expanded and modernised over the last three years and is now one of the largest and most modern cider production units in Europe. The company specialises in producing high quality ciders and perry and combines the latest production technology with traditional methods.

Successful operation of the processing plant depends on the quality of the Kent instrumentation used.

Contact: Kent Industrial Measurements Ltd, Oldends Lane, Stonehouse, Gloucestershire GL10 3TA. Tel: (045 382) 6661.

CHIP COUNT!

This month's list of new component details received — mainly chips, but other items may be included.

83C43. 8-bit microcontroller with 4K bytes of ram, 128 bytes of rom and an on-chip lcd driver supporting four backplanes at a maximum driving capacity of 96 segments. **(ML)**

FXD580 series of Ferroxdure materials for permanent magnets in dc motors. The FXD500 has typical remanence and coercivity values of 385mT and 360kAm respectively. The FXD520 has equivalent values of 425mT and 260kAm. **(ML).**

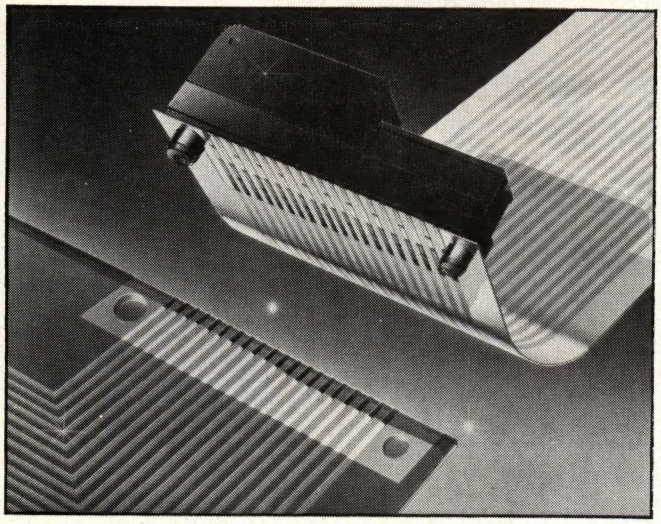
HA19213NT. Low power monolithic 7-bit flash ADC. Typical power dissipation 250mW, conversion rate 30 msps. **(HT).**

LM282XF. LCD 640 x 400 dot display with built in cold fluorescent lamp backlighting, offering increased lifetime and superior visual performance. **(HT).**

PLC473. The first Mullard erasable pld. Manufactured in cmos, it features uv erasability and demands much less power than its bipolar equivalents. **(ML).**

Manufacturers, and contact telephone numbers:

(HT) Hitachi Electronic Components UK Ltd, 21 Upton Road, Watford, Herts, WD1 7TB. 0923 246488.
(ML) Mullard Ltd, Mullard House, Torrington Place, London WC1E 7HD. 01 580 6633.



Snap, No Crackle

Dowty's SNAP (sustained necessary applied pressure) has now been successfully evaluated to meet environmental classifications and provides gas tight contact between conductors on rigid circuit boards and tape cable or custom designed flexible circuits.

The new design has a number of advantages over conventional IDC and permits its use in many applications at lower cost. The combination of SNAP and production runs of pcbs provides a material cost saving since the mounting site does not require through-hole plating or mating connectors. It also has a greater intrinsic reliability than IDC due to its single interface between flex and rigid circuit. IDC would require three interfaces to make an equivalent connection.

The SNAP system is available as a single unit capable of 20 or 40 connection lines per 25 mm.

Contact: Dowty Interconnect, Knaves Beech Business Centre, Loudwater, High Wycombe, Bucks HP10 9UT, Tel: 0628 810810.

CD-ROMPS On

Britain's leading compact disc manufacturer, Nimbus Records, has completed the first commercial production of a cd-rom. The disc, commissioned by Clarinet Systems Limited for distribution to the international oil community, features a digital cartographic database of the world. It marks yet another first for Nimbus in technological achievement.

With the capacity to store up to 200,000 pages of text or 1,500 floppy discs, cd-rom (compact disc read only memory) is the latest means of storing vast amounts of data on a world standard optical storage medium.

The cd-rom manufactured by Nimbus holds 550 Mbytes of mapping data and runs on a PC linked to a plotter. While three scales and two projections are published on the disc, the software allows the user to zoom in and out with a choice of 26 projections.

The software supplied by Clarinet means that the user can distinguish specific geographical regions, cities or landmarks, highlighted by a colour display of distinctive boundaries and geographical features. Using a large scale or PC plotter, a full colour plot can then be displayed. Stephen Scholefield of Clarinet commented on the production of the disc: "Nimbus offered us a very quick turnaround time combined with extremely fast and efficient service."

Emil Dudek, cd-rom manager at Nimbus said that they are delighted to have reached the position where they can now offer a complete cd-rom manufacturing service. While this first disc is a combination of text and graphics, the versatility of cd-rom in other areas of storage such as audio-visual data is not being overlooked. Nimbus are committed to technological development and are determined to forge ahead with exciting new applications of compact disc.

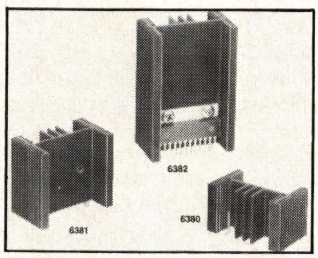
Contact: Emil Dudek, Nimbus Records. Tel: (0600) 890 682.

Cool Sip-Zip

If you are using integrated circuits encased in single or zig-zag in-line plastic packages, then you will be interested to learn about Thermalloy's latest 6380 Series heatsinks which are designed for both sip and zip, providing heat dissipation up to the 10–15W range.

The series is fitted with standard solderable roll pins, but users can also specify these with stand-off shoulders. There are several labour saving mounting options. The heatsinks can be screw mounted, using the pre-drilled device tab, or supplied with self-clinching fasteners or threaded studs. The TO220 case style devices is also available with a slotted hole pattern for mounting with a secondary clip.

Contact: MCP Electronics Ltd, 26–32 Rosemont Road, Alperton, Wembley, Middx HA0 4QY. Tel: 01 902 1191.



Firelight

Photain Controls are now manufacturing a new smoke detection unit which operates on the light scattering principle.

The unit comprises a white circular plastic housing which is normally fitted on the ceiling and contains an infra red light source which is pulsed and thereby produces a beam of invisible light. When smoke enters the unit through the special inlet holes the smoke scatters the beam which is then reflected on to the photocell. The photocell passes this information to an evaluation circuit within the unit which measures the amount of light received and compares it to a reference. The unit is triggered into an alarm state when the amount of smoke, which is in direct proportion to the amount of light falling on the photocell, exceeds a pre-set level.

The unit operates over a voltage range of 10–30V dc and any number of detectors can be wired in parallel across the same supply lines.

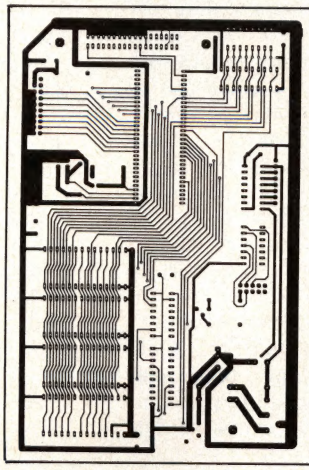
The price complete with plug in base is £36.00. Trade and quantity discounts available.

Contact: Photain Controls Ltd, Ford Aerodrome, Arundel, West Sussex, BN18 0BE. Tel: 0903 721531.

Snow Track

Skiers unfortunate enough to be buried by an avalanche may no longer be dependent upon rescue teams using tracker dogs and long metal probes. A Swiss firm, Asulab SA, has filed a European patent application (EP 0 172 445) for a radio activated location indicator device.

The proposed solution is for everyone at risk to wear a bracelet, like a watch strap, in which is a passive transceiver. It has an aerial made of metal foil, but needs neither batteries nor a conventional transmitter. Search signals transmitted by the rescue team are strong enough to generate a current in the bracelet. The current passes through a non-linear circuit which halves or doubles the frequency and rebroadcasts it through the foil aerial. The rescuers listen for signal echoes at the different frequency and determine the exact source of the signal with a directional aerial. Because the bracelet is passive it works automatically, and without the problem of lost battery power.



Track Pack

Lintrack PC, a low cost but professional pcb design package for IBM PCs and compatibles is now available from Linear Graphics Ltd.

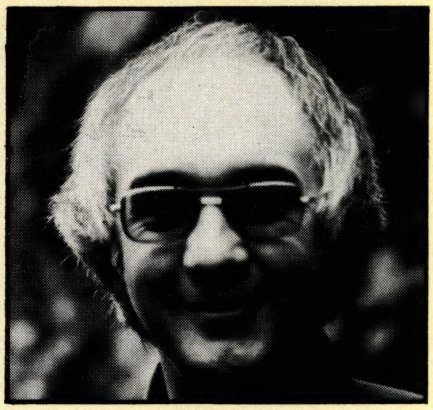
It costs £160 plus VAT, but offers many features that are normally only offered on very much more expensive packages. Components can be placed using a 10 thou grid on double-sided boards up to 19 ins × 20 ins allowing maximum flexibility.

The user is provided with powerful editing features that allow any group of items (each item is a pad or section of track) to be selected from throughout the layout and to be relocated, rotated, duplicated or erased. User may also create their own library items speeding up the design process.

Lintrack PC offers comprehensive screen viewing, all layers or any one layer for selective editing, plus four levels of magnification. The package comes complete with a pre-defined library of dil outlines, connectors, transistors and pad layouts.

Contact: Linear Graphics Ltd, 28 Purdeys Way, Rochford, Essex SS4 1NE. Tel: 0702 541663/4/5.

LEADING EDGE



By Barry Fox – Winner of the 1987 UK Technology Press Award

FAVOURITE CD TRACKS

Philips CD players use eproms that allow permanent track selections to be stored in non-volatile memory.

There is interesting technology inside the new Philips cd players with fts (favourite track selection). To re-cap briefly, fts means what it says. You can select your favourite tracks on a compact disc, and ignore the ones you don't like.

On existing players you have to program the player with your selection every time you play a disc. With fts you can keep the selection stored in the player so that whenever the disc is loaded, the same selection of tracks is played and ignored. The player is able to recognise a disc and automatically recall the matching menu of hates and favourites for that disc. So far only Philips players have fts, because the technology is proprietory.

Around 97% of the digital bits streaming off an audio compact disc are used for stereo sound; the other 3% are used for "sub codes" which have nothing to do with music. There are eight separate subcode channels. The first two, known as P and Q, are used to control the player – eg tell it when music tracks begin and end. The other six (R-W) can be used for graphics and text displayed on a tv screen.

To make a brief detour from fts, the cd graphics system is already used in Japan for karaoke; that's a musical backing track for drunks in bars to singalong with, while watching the song lyrics come up on screen. There is a choice of 16 colours per picture with a total "palette" choice of 4096 colours. The sub code data comes off disc at around 60 kilobits per second and of this around 45 kilobits/second are available for text and graphics. This is enough to give one fresh picture every two seconds, of resolution 288×192 pixels.

The disc coding follows a world standard but the decoder must match local tv standard, ie one disc will play anywhere in the world but a PAL decoder and tv are needed for Europe and an NTSC decoder and tv for US/Japan. This means there is slight shape distortion, ie a circle looks a bit oval, but it hardly matters for karaoke lyrics. So far only NTSC decoders are available. So British pubs are still safe from karaoke.

Most cd audio players now have a microprocessor which the user can program to search for selected PQ codes. This is how the player can skip between tracks, with the order in which they are played bearing no relation to the order in which they are recorded on the disc. But the memory is volatile.. When another disc is programmed, the last track selection is lost.

Philips fts uses a non-volatile memory which holds instructions even when the mains is switched off. The player automatically recognises any disc on which it holds instructions, and calls up the right menu from its memory. Although it is possible to identify a compact disc by coding its title or catalogue number into the digital sub-code stream, record companies seldom bother to do this. So the fts player must use another trick to identify a disc. It compares the number of musical tracks with their length. Philips reckon there is only a one in a billion chance of two discs having exactly the same characteristic. So as soon as a record is loaded into the player, the fts circuit scans its contents, then scans its memory and if there are two matching entries it plays only those tracks on the disc which the owner previously chose.

The memory lasts for ever, unless the owner chooses to erase or change an entry. The menus are not lost when the player is switched off or even unplugged from the mains. This clever trick is done with eeproms.

Electrically erasable programmable read only memory is a technology, similar to the eproms (eraseable proms) used in portable computers, like the Psion Organiser.

Prom is a matrix of memory cells with silicon junctions or gates which can be opened and closed by an electrical signal to create a digital pattern of ones and zeroes. When the memory is new, all the juntions are switched in the same direction. To store data a control computer sends the memory chip a stream of electrical pulses which progressively switch some of the junctions by forcing electrons to cross a silicon semiconductor barrier. Once switched the junctions then stay switched. The pattern of switching conveys the data. Each chunk of data stored in the chip is labelled so that it can either be recalled for display on screen or erased.

Once switched, the gates of an eprom stay switched, until the whole memory matrix is saturated in ultraviolet light at a frequency of around 2537 Angstrom, for around 20 minutes. This drives the electrons back to their natural state and clears the entire memory. The uv content in daylight, or from a domestic tanning lamp, is not strong enough to do the job unless concentrated into a very narrow beam. With eeprom, as used for fts and (pre-set controls in radio and tv tuners) the data is erased electrically, rather than with uv light.

The memory capacity of the eeprom in the Philips fts players is 2049 bytes, of which 2045 bytes are available for use. Each entry for a disc consists of an eight byte header which identifies the disc by length of music programme. The user selection for the disc takes up between one and five bytes per track, depending on whether times and index points are stored as well as track numbers. A maximum of 20 bytes can be programmed per track.

Obviously the number of discs on which information can be stored depends on how much information is stored for each disc. It takes 13 bytes of memory to identify the running order for five tracks – less bytes for less tracks, and more bytes for more tracks. So total storage capacity can be over 150 discs with information on five tracks each; or around 80 if begin and end times are also stored; or something in between if the amount of information varies from disc to disc.

When data is erased from eeprom, the wiped cells can be used again to store fresh data. This is not the case with eprom; the memory cells are "eaten away" like gorgonzola cheese as data is erased from them. The erase command simply puts a "flag" on some of the labels which tells the control computer that a chunk of data is no longer needed. The switch junctions remained switched. With an eprom you can end up with no data stored, but no memory capacity left. The eprom chip then has to be wiped clean and rejuvenated with uv light.

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Mark Taylor, from an idea by John Becker.

WEATHER WATCHING

One of the many benefits brought about by satellites is that of improved weather monitoring on a scale unimaginable during the last century.

Widescale weather monitoring really began in the 1840s when electric telegraphs came into use in a storm warning network across the USA. About the same time daily weather maps became available both in the USA and in England. By the 1850s Europe had a rudimentary weather monitoring network centred on the Paris Observatory which received reports along links made available by the newly formed International Telegraphic Union. International weather bulletins had become available by the 1860s and in the 1870s the World Meteorological Organisation was founded in Vienna.

Over the next hundred years, as technology advanced so radio telegraphy, land and sea cable links followed bringing wider globe spanning observations, facilitated by the cooperation of the ITU and WMO.

By the 1960s the WMO recognised the necessity for long range planning as well as forecasting and created a World Weather Watch programme. Currently, 158 WMO member countries and territories participate in the WWW and have at their command data from over ten thousand weather monitoring stations across the globe. The monitors include those on land, at sea, on aircraft and weather balloons, and since 1959 on satellites as well.

Vanguard II was the first weather satellite to be launched, though Tiros IX was the first satellite to produce full-planet photographs, in 1965. Today over 300 earth stations across the globe collect the data from eight principal satellites in polar and geostationary orbit, and more satellites are planned.

Some of the world's most powerful computers analyse the data and make long term forecasts. Full perfection has not yet been achieved (don't we know it!) and may remain unachievable for many years due to the complexity of airflow mathematics and current shortage of monitoring stations. But, as the technology improves so too will the accuracy, allowing appropriate action to be taken to minimise potential disasters.

Many benefits are already gained from the ability to monitor and predict weather conditions. Travel safety, harvest protection, flood and drought prediction are just some of the obvious areas influenced by increased forecast accuracy. Other aspects of society have benefited too, for example, satisfactory forecasting results in better scheduling of power generation to meet weather dependent demand, so minimising operational costs. Airlines benefit from lower fuel costs when flights can be routed round adverse weather conditions. Environmental polution monitoring and control can also gain from knowledge of atmospheric movements. And naturally, military defense and offense tactics are influenced by sophisticated analysis of forthcoming weather trends.

SF writers often predict that weather control will one day come about, though the practicalities and benefits of this are highly debatable. And I'm not sure that it would be fully appreciated – what would we have to talk about?

THE EDITOR

OUR MAY 1988 ISSUE WILL BE ON SALE FRIDAY, APRIL 8th 1988 (see page 2)

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All modems carry a full BT approval

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* If purchased with any of the above modems * ***£70 (c)**

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(Offer limited to current stocks)

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This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV – has a serial and parallel I/O routines. Can be used as an emulator, cassette interface.
Softy II **£195.00(b)**
Adaptor for 2764/2564 **£25.00**

SPECIAL OFFER
2764-25 £3.00 (d);
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RT256 3 PORT SWITCHOVER SERIAL INTERFACE
3 input/1 output or 1 input/3 output manual channel selection. Input/output baud rates, independently selectable 7 bit/8 bit, odd/even/none parity. Hardware or software handshake. 256K buffer, mains powered **£375 (b)**

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Internal buffer for most Epson printers. Easy to install. Inst. supplied.
PB128 128K **£99 (c)**

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No of ways	Header Plug	Recep-tacle	Edge Conn
10	**90p**	**85p**	**120p**
20	**145p**	**125p**	**195p**
26	**175p**	**150p**	**240p**
34	**200p**	**160p**	**320p**
40	**220p**	**190p**	**340p**
50	**235p**	**200p**	**390p**

D CONNECTORS

No of Ways	9	15	25	37
MALE:				
Ang Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	—
FEMALE:				
St Pin	100	140	210	380
Ang Pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	—
St Hood	90	95	100	120
Screw Lock	130	150	175	—

TEXTOOL ZIF

SOCKETS 24-pin **£7.50** 28-pin **£9.10** 40-pin **£12.10**

EDGE CONNECTORS

	0.1	0.156
2 × 6-way (commodore)	—	300p
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2 × 12-way (vic 20)	—	350p
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2 × 23-way (ZX81)	175p	220p
2 × 25-way	225p	220p
2 × 28-way (Spectrum)	200p	—
2 × 36-way	250p	—
1 × 43-way	260p	—
2 × 22-way	190p	—
2 × 43-way	395p	—
1 × 77-way	400p	500p
2 × 50-way(S100conn)	600p	—

EURO CONNECTORS

DIN 41612	Plug	Skt
2 × 32 way St Pin	**230p**	**275p**
2 × 32 way Ang Pin	**275p**	**320p**
3 × 32 way St Pin	**260p**	**300p**
3 × 32 way Ang Pin	**375p**	**400p**
IDC Skt A + B	**400p**	
IDC Skt A + C	**400p**	

For 2 × 32 way please specify spacing (A + B, A + C).

MISC CONNS

21 pin Scart Connector **200p**
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AMPHENOL CONNECTORS

36 way plug Centronics (solder **500p** (IDC) **475p**
36 way skt Centronics (solder) **550p** (IDC) **500p**
24 way plug IEEE (solder) **475p** (IDC) **475p**
24 way skt IEEE (solder) **500p** (IDC) **500p**
PCB Mtg Skt Ang Pin
24 way **700p** 36 way **750p**

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25 way D type

Male to Male £10
Male to Female £10
Female to Female £10

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(25 way D)

24" Single end Male **£5.00**
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24" Female Female **£10.00**
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24" Male Female **£9.50**

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PS351 Single 400K/640K with integral mains power supply **£119 (b)**
TD352 Dual 800K/1280K **£170 (b)**
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TAXAN 12" HI-RES
KX1201G green screen **£90 (**
KX1203A amber screen **£95 (**

PHILIPS 12" HI-RES
BM7502 green screen **£75 (**
BM7522 amber screen **£79 (**
8501 RGB Std Res **£139 (**

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Taxan Mono Swivel Base with clock **£22 (**
Philips Swivel Base **£14 (**
BBC RGB Cable **£5 (**
Microvitec **£3.50 (**
Taxan **£5 (d)**..... Monochrome **£3.50 (**
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UV1T Eraser with built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays.
It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. **£59 + £2 p&p.**
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For Industrial Users, we offer UV140 & UV141 erasers with handling capacity of 14 eproms. UV141 has a built in timer. Both offer full built in safety features UV140 **£69**, UV141 **£85, p&p £2.50.**

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(grey/metre)

10-way	40p	34-way	16(
16-way	60p	40-way	18(
20-way	85p	50-way	20(
26-way	120p	64-way	28(

DIL HEADERS

	Solder	IDC
14 pin	40p	100p
16 pin	50p	110p
18 pin	60p	—
20 pin	75p	—
24 pin	100p	150p
28 pin	160p	200p
40 pin	200p	225p

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All prices in this double p advertisement are subject change without notice. ALL PRICES EXCLUDE V Please add carriage 50 unless indicated as follow (a) £8 (b) £2.50 (c) £1.50 £1.00

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0	0.30
1	0.30
2	0.30
3	0.30
4	0.36
5	0.30
6	0.40
7	0.40
8	0.30
9	0.30
0	0.30
1	0.30
2	0.30
3	0.50
4	0.70
6	0.36
7	0.40
0	0.30
1	0.60
2	0.36
3	0.36
5	0.40
6	0.40
7	0.32
8	0.43
0	0.30
2	0.36
3	0.30
7	0.30
8	0.40
9	0.40
0	0.40
1	0.90
2A	0.70
3A	1.00
4	1.10
5	0.70
6A	1.00
7A	1.00
8	1.00
0	0.36
1	0.35
3	0.38
4	0.38
0	0.55
70	0.50
72	0.45
73	0.45
74	0.50
75	0.80
76	0.45
30	0.85
1	1.80
3A	1.05
4A	1.25
5	1.10
6	0.42
9	2.10
0A	0.55
1	0.70
2A	0.70
3A	0.55
4	1.10
5	0.60
6	0.80
7	2.90
00	1.90
07	0.50
09	0.75
10	0.75
11	0.55
16	1.70
18	1.10
19	1.70
20	1.00
21	0.55
22	0.70
23	0.80
25	0.65
26	0.55
28	0.55
32	0.75
36	0.70
41	0.90
42	2.50
43	1.30
44	2.70
45	1.10
47	1.70
48	1.40
50	1.75
51A	0.70
53	0.80
54	1.40
55	0.80
56	0.90
59	2.25
60	1.10
61	0.80
62	1.10
63	1.10
64	1.20
65	1.10
66	1.40
67	4.00
70	2.00
72	4.20
73	1.40
74	1.10
75	1.05
76	1.00
78	1.50
80	1.00
81	3.40
82	1.40
84	1.80
85A	1.80
90	1.30
91	1.30
92	1.10
93	1.15
94	1.10
95	0.80
96	1.30
97	1.10
98	2.20
99	2.20
21	1.10
51	1.00
59	1.50
75	0.80
73	2.00
76	1.40
78	1.70

74LS SERIES

74LS00	0.24
74LS01	0.24
74LS02	0.24
74LS03	0.24
74LS04	0.24
74LS05	0.24
74LS08	0.24
74LS09	0.24
74LS10	0.24
74LS11	0.24
74LS13	0.34
74LS14	0.50
74LS15	0.24
74LS20	0.24
74LS21	0.24
74LS22	0.24
74LS24	0.50
74LS26	0.26
74LS27	0.24
74LS28	0.24
74LS30	0.24
74LS32	0.24
74LS33	0.24
74LS37	0.24
74LS38	0.24
74LS40	0.24
74LS42	0.50
74LS43	1.50
74LS48	0.90
74LS49	1.00
74LS51	0.24
74LS54	0.24
74LS55	0.24
74LS73A	0.30
74LS74A	0.35
74LS75	0.45
74LS76A	0.36
74LS78	0.42
74LS83A	0.70
74LS85	0.75
74LS86	0.35
74LS90	0.48
74LS92	0.35
74LS93	0.54
74LS95B	0.75
74LS96	0.90
74LS107	0.40
74LS109	0.40
74LS112	0.45
74LS113	0.45
74LS114	0.45
74LS122	0.70
74LS123	0.80
74LS125	0.50
74LS126	0.50
74LS132	0.65
74LS133	0.55
74LS136	0.45
74LS138	0.55
74LS139	0.55
74LS145	0.95
74LS147	1.75
74LS148	1.40
74LS151	0.65
74LS152	2.00
74LS153	0.65
74LS154	1.60
74LS155	0.65
74LS156	0.65
74LS157	0.50
74LS158	0.50
74LS160A	0.65
74LS161A	0.75
74LS162A	0.75
74LS163A	0.75
74LS164	0.75
74LS165A	1.10
74LS166A	1.50
74LS168	1.30
74LS169	1.00
74LS170	1.40
74LS173A	1.00
74LS174	0.75
74LS175	0.75
74LS181	2.00
74LS183	1.90
74LS190	0.75
74LS191	0.75
74LS192	0.80
74LS194A	0.75
74LS195A	0.75
74LS196	0.80
74LS197	0.80
74LS221	0.90
74LS240	0.80
74LS241	0.80
74LS242	0.90
74LS243	0.90
74LS244	0.70
74LS245	0.90
74LS247	1.10
74LS248	1.10
74LS249	1.10
74LS251	0.75
74LS253	0.75
74LS256	0.90
74LS2457A	0.70
74LS258A	0.70
74LS259	1.20
74LS260	0.75
74LS266	0.60

74279	0.90
74283	1.05
74742	3.20
74290	0.90
74293	0.90
74298	1.80
74351	2.00
74365A	0.80
74366A	0.80
74367A	0.80
74376	1.60
74390	1.10
74393	1.20
74490	1.40

74LS273	1.25
74LS279	0.70
74LS280	1.90
74LS283	0.80
74LS290	0.80
74LS292	14.00
74LS293	0.80
74LS295	1.40
74LS297	14.00
74LS298	1.00
74LS299	2.20
74LS321	3.70
74LS322A	3.90
74LS323	3.00
74LS324	3.20
74LS348	2.00
74LS352	1.20
74LS353	1.20
74LS356	2.10
74LS363	1.80
74LS364	1.80
74LS365	0.50
74LS366	0.50
74LS367	0.52
74LS368	0.50
74LS373	0.70
74LS374	0.70
74LS375	0.75
74LS377	1.30
74LS378	0.95
74LS379	1.30
74LS381	4.50
74LS385	3.25
74LS390	0.80
74LS393	1.00
74LS395A	1.00
74LS399	1.40
74LS445	1.80
74LS465	1.20
74LS467	1.20
74LS490	1.50
74LS540	1.00
74LS541	1.00
74LS640-1	3.00
74LS641	1.50
74LS642	2.50
74LS642-1	3.00
74LS643	2.50
74LS643-1	3.00
74LS644	3.50
74LS645	2.00
74LS645-1	4.00
74LS668	0.90
74LS669	0.90
74LS670	1.70
74LS682	2.50
74LS683	3.00
74LS684	3.50
74LS687	3.50
74LS688	3.50
74LS783	16.00

74S SERIES

74S00	0.50
74S02	0.50
74S04	0.50
74S05	0.50
74S08	0.50
74S10	0.50
74S11	0.75
74S20	0.50
74S22	0.50
74S30	0.50
74S32	0.60
74S37	0.60
74S38	0.60
74S40	0.50
74S51	0.60
74S64	0.45
74S74	0.75
74S85	5.50
74S86	1.00
74S112	0.90
74S113	1.20
74S114	1.20
74S124	3.00
74S132	1.00
74S133	0.60
74S138	1.80
74S139	1.80
74S140	1.00
74S151	1.50
74S153	1.50
74S157	2.00
74S158	2.00
74S163	3.00
74S169	5.50
74S174	3.00
74S175	3.20
74S188	1.80
74S189	1.80
74S194	3.00
74S195	3.00
74S196	3.50
74S200	4.50
74S201	3.20
74S225	5.20
74S240	4.00
74S241	4.00
74S244	4.00
74S251	2.50
74S257	2.50
74S258	2.50
74S260	1.00
74S261	3.00
74S263	2.70
74S287	2.25
74S288	2.00
74S289	2.25
74S299	4.50
74S373	4.00
74S374	4.00
74S387	2.25

Special offer to PE readers only – 10% off on all TTLS and CMOS

74ALS SERIES

74ALS00	0.45
74ALS02	0.45
74ALS04	0.50
74ALS08	0.50
74ALS10	0.45
74ALS20	0.45
74ALS32	0.45
74ALS74	0.70
74ALS138	1.50
74ALS139	1.50
74ALS244	4.00
74ALS245	4.75
74ALS573	2.60
74ALS574	4.50
74ALS580	2.60

4000 SERIES

4000	0.20
4001	0.24
4002	0.25
4006	0.70
4007	0.25
4008	0.60
4009	0.45
4010	0.60
4011	0.24
4012	0.25
4013	0.36
4014	0.60
4015	0.70
4016	0.36
4017	0.55
4018	0.60
4019	0.60
4020	0.80
4021	0.60
4022	0.70
4023	0.30
4024	0.48
4025	0.24
4026	0.90
4027	0.40
4028	0.60
4029	0.75
4030	0.35
4031	1.25
4032	1.00
4033	1.25
4034	2.50
4035	0.70
4036	2.50
4037	1.10
4038	1.00
4040	0.60
4041	0.55
4042	0.50
4043	0.60
4044	0.60
4045	1.00
4046	0.60
4047	0.60
4048	0.55
4049	0.36
4050	0.35
4051	0.65
4052	0.60
4053	0.60
4054	0.80
4055	0.80
4056	0.85
4060	0.70
4063	0.85
4066	0.40
4067	2.30
4068	0.25
4069	0.24
4070	0.24
4071	0.24
4072	0.24
4073	0.24
4075	0.24

4076	0.65
4077	0.25
4078	0.25
4081	0.24
4082	0.25
4085	0.60
4086	0.75
4089	1.20
4093	0.35
4094	0.90
4095	0.95
4096	0.90
4097	2.70
4098	0.75
4099	0.99
4501	0.36
4502	0.55
4503	0.36
4504	0.95
4505	3.60
4506	0.90
4507	0.35
4508	1.20
4510	0.55
4511	0.55
4512	0.55
4513	1.50
4514	1.10
4515	1.10
4516	0.55
4517	2.20
4518	0.48
4519	0.32
4520	0.60
4521	1.15
4522	0.80
4526	0.70
4527	0.80
4528	0.65
4529	1.00
4531	0.75
4532	0.65
4534	3.80
4536	2.50
4538	0.75
4539	0.75
4541	0.90
4543	0.70
4551	1.00
4553	2.40
4555	0.36
4556	0.50
4557	2.40
4560	1.40
4566	1.40
4568	2.40
4569	1.70
4572	0.45
4583	0.90
4584	0.48
4585	0.60
4724	1.50
14411	7.50
14412	7.50
14416	3.00
14419	2.60
14490	4.20
14495	4.50
145000	6.50
14599	2.00
22100	3.50
22101	7.00
22102	7.00
40014	0.48
40085	1.20
40097	0.36
40098	0.40
40100	1.50
40101	1.25
40102	1.30
40103	2.00
40104	1.20
40105	1.50
40106	0.48
40107	0.55
40108	3.20
40109	0.80
40110	2.25
40114	2.25
40107	2.80
40163	1.00
40173	1.20
40174	1.00
40175	1.00
40192	1.00
40193	1.00
40194	1.00
40244	1.50
40245	1.50
40257	1.80
40373	1.80
40374	1.80
80C95	0.75
80C97	0.75
80C98	0.75

LINEAR ICs

ADC0808	11.90
AM7910DC	25.00
AN103	2.00
AN-1-5050	1.00
AY-3-1350	5.00
AY-3-8910	4.90
AY-3-8912	5.00
CA3019A	1.00
CA3020	3.50
CA3028A	1.10
CA3046	0.70
CA3059	3.25
CA3060	3.50
CA3080E	0.70
CA3085	1.50
CA3086	0.60
CA3089E	2.50
CA3090AQ	3.75
CA3130E	0.90
CA3130T	1.30
CA3140E	0.45
CA3140T	1.00
CA3146	2.25
CA3160E	1.50
CA3161E	2.00
CA3162E	6.00
CA3189E	2.70
CA3240E	1.50
CA3280G	3.00
D7002	6.00
DAC1408-8	3.00
DAC0800	3.00
DAC0808	3.00
DG308	3.00
HA1366	1.90
ICL7106	6.75
ICL7611	0.95
ICL8038	4.00
ICM7555	0.90
ICM7556	1.40
LC7120	3.00
LC7130	3.00
LC7131	3.50
LC7137	3.50
LF347	1.20
LF351	0.60
LF353	0.90
LF355	0.90
LF356N	1.10
LF357	1.00
LF398	4.00
LM10CLH	4.50
LM301A	0.30
LM307	0.45
LM308CN	0.75
LM310	2.25
LM311	0.60
LM318	1.50
LM319	1.80
LM324	0.45
LM334Z	1.15
LM335Z	1.30
LM336	1.60
LM339	0.40
LM348	0.60
LM358P	0.50
LM377	3.00
LM380N-8	1.50
LM380N	1.50
LM383	3.25
LM384	2.20
LM386N-1	1.00
LM387	2.70
LM391	1.80
LM392N	1.10
LM393	0.85
LM394CH	4.00
LM709	0.35

LM710	0.48
LM711	1.00
LM723	0.60
LM725CN	3.00
LM733	0.65
LM741	0.22
LM7747	0.70
LM748	0.30
LM1011	4.80
LM1014	1.50
LM1801	3.00
LM1830	2.50
LM1871	3.00
LM1872	3.00
LM1886	6.00
LM1889	4.50
LM2917	3.00
LM3302	0.90
LM3900	0.80
LM3909	1.40
LM3911	1.80
LM3914	3.50
LM3915	3.40
LM3916	3.40
LM13600	1.50
M51513L	2.30
M51516L	4.50
MB3712	2.00
MC1310P	1.50
1413	0.75
MC1458	0.45
MC1495	3.00
MC1496	0.70
MC3340P	2.00
MC3401	0.70
MC3404	0.65
MF10CN	4.10
MK50240	9.00
ML902	5.00
ML922	4.00
MM6221A	3.00
NE529	2.20
NE531	1.20
NE544	1.90
NE555	0.22
NE556	0.60
NE564	4.00
NE565	1.20
NE566	1.50
NE567	1.25
NE570	4.00
NE571	3.00
NE592	0.90
NE5532P	1.50
NE5533P	1.60
NE5534P	1.20
NE5534AP	1.50
OP-07EP	3.50
PLL02A	5.00
RC4136	0.55
RC4151	2.00
RC4195	1.50
RC4558	0.55
S50240	9.00
SFF96364	8.00
SL490	3.00
SN76013N	5.00
SN76033N	5.00
SN76115N	2.15
SN76489	4.00
SN76495	4.00
SN76660	1.20
SPO256AL2	7.00
SP8515	7.50
TA7120	1.20
TA7130	1.40
TA7204	1.50
TA7205	0.90
TA7222	1.50
TA7310	1.50

TBA231	1.20
TBA800	0.80
TBA810	0.90
TBA20	0.80
TBA820M	0.75
TBA920	2.00
TBA950	2.25
TC9109	5.00
TCA270	3.50
TCA940	1.75
TDA1010	2.25
TDA1022	4.50
TDA1024	1.10
TDA1170S	3.00
TDA2002	3.25
TDA2003	1.90
TDA2004	2.40
TDA2006	3.20
TDA2030	2.50
TDA2593	5.00
TDA2653	7.00
TDA3560	7.50
TDA3810	7.50
TDA7000	3.50
TEA1002	7.00
TL061CP	0.40
TL062	0.60
TL064	0.90
TL071	0.40
TL072	0.70
TL074	1.10
TL081	0.35
TL082	0.55
TL083	0.75
TL084	1.00
TL094	2.00
TL430C	1.20
UA759	3.20
UA2240	1.20
UCN5801A	6.00
ULN2001A	0.75
ULN2002A	0.75
ULN2003A	0.75
ULN2004A	0.75
ULN2068	2.90
ULN2802	1.90
ULN2803	1.80
ULN2804	1.90
UPC575	2.75
UPC592H	2.00
UPC1156H	3.00
UPC1185H	5.00
XR210	4.00
XR2206	4.50
XR2207	3.75
XR2211	5.75
XR2216	6.75
XR2249	1.20
ZN404	1.00
ZN414	0.80
ZN419P	1.75
ZN423E	1.30
ZN424E	1.30
ZN425EB	3.50
ZN426E8	3.00
ZN427EB	6.00
ZN428EB	4.50
ZN429E8	2.25
ZN447E	9.00
ZN448I	7.50
ZN449E	3.00
ZN450E	7.50
ZN459CP	3.00
ZN1034E	2.00
ZNA1040	6.60
ZNA134H	23.00
ZNA234E	9.50

VOLTAGE REGULATORS

1A FIXED VOLTAGE PLASTIC TP220

+ VE		– VE	
5V 7805	0.45	7905	0.50
6V 7806	0.50	7906	0.50
6V 7808	0.50	7908	0.50
12V 7812	0.45	7912	0.50
15V 7815	0.50	7915	0.50
18V 7818	0.50	7918	0.50
24V 7824	0.50	7924	0.50

1A FIXED VOLTAGE PLASTIC TO92

5V 78L05	0.30	5V 79L05	0.45
6V 78L06	0.30	12V 79L12	0.50
8V 78L08	0.30	15V 79L15	0.50
12V 78L12	0.30		
15V 78L15	0.30		

OTHER REGULATORS

FIXED REGULATORS

LM309K	1A 5V	1.40
LM323K	3A 5V	3.50
L78H05KC	5A 5V	7.50

VARIABLE REGULATORS

LM305AH		2.50
LM317T	TO-220	1.20
LM317K	TO3	2.40
LM337T		2.25
LM350T		4.00
LM723N		0.50

SWITCHING REGULATORS

ICL7660	2.50
SG3524	3.00
TL494	3.00
TL497	2.25
78S40	2.50
RC4195	1.50

COMPUTER COMPONENTS

CPUs

1802CE	6.50
2650A	10.50
6502	4.50
65C02-2MHz	12.00
6502A	6.50
6502B	8.00
6800	3.50
6802	3.50
6809	6.50
6809E	10.00
68B09	10.00
68B09E	12.00
68000-LB	36.00
8035	3.50
80C35	6.00
8039	4.20
80C39	7.00
8080A	9.50
8085A	3.00
80C85A	7.50
8086	22.00
8087-5	£120
8087-8	£160
8088	17.50
8741	15.00
8748	10.00
TMS1601	12.00
TMS9980	14.50
TMS9995	18.00
V20-8	12.00
V30-8	12.00
Z80	2.50
Z80A	2.90
Z80B	5.50
Z80H	7.50

SUPPORT DEVICES

2651	12.00
3242	8.00
3245	4.50
6520	3.00
6522	3.50
6522A	5.50
6532	4.80
6551A	6.00
6821	1.60
68B21	2.50
68040	3.75
68B40	6.00
6850	1.80
68B50	2.50
6852	2.50
6854	6.50
68B54	8.00
8154	8.50
8155	3.80
8156	3.80
8205	2.25
8212	2.00
8216	1.60
8224	POA
8226	4.25
8228	5.50
8237	6.50
8243	2.60
8250	12.00
8251A	3.25
8253C-5	3.50
8255AC-5	3.20
8256	18.00
8257C-5	54.00
8259C-5	4.00
8275	29.00
8279C-5	4.80
8282	4.00
8284	4.60
8287	3.80
8288D	6.50
8755A	16.00

MEMORIES

2114-3	1.00
4116-2	1.50
4164-15	1.50
41256-15	3.50
41464-15	3.50
4416	3.00
5101-3	5.00
6116LP-15	2.80
62256	9.50
6810	2.50

PROMS

28L22	4.00
74S188	1.80
74S287	2.25
74S288	1.80
74S387	2.25
82S23	1.50
82S123	1.50
82S129	1.75

IBM AMSTRAD UPGRADES

8087-5	£120
8087-8	£160
80287-5	£160
80287-8	£260
80287-10	£320

TMS4500	14.00
TMS9901	5.00
TMS9902	5.00
TMS9914	14.00
Z80PIO	2.50
Z80APIO	2.75
Z80CTC	2.50
Z80ACTC	2.75
Z80DART	6.50
Z80ADART	7.00
Z80DMA	7.00
Z80ADMA	7.50
Z80ASIO/0/2/9	7.00
Z80BPIO	5.00
Z80BPIO	5.00
Z80BCTC	5.00
Z80BDART	9.00

RS232

MAX232	7.50

CRT CONTROLLER

CRT5037	12.00
CRT6545	9.00
EF9364	8.00
EF9365	32.00
EF9366	32.00
EF9367	36.00
EF9369	12.00
MC6845	6.50
MC6845SP	6.50
MC6847	6.50
SFF96364	8.00
TMS9228	10.00

INTERFACE ICs

ADC0808	10.00
AD561J	20.00
AM25S10	3.50
AM25LS2521	3.50
AM25LS2538	3.50
AM26LS31	1.20
AM26LS32	1.20
AM7910DC	25.00
DM8131	6.00
DP8304	4.50
DS3691	4.50
DS8830	1.40
DS8831	1.50
DS8832	1.50
DS8833	2.25
DS8836	1.50
DS8838	2.25
D7002	6.00
MC1488	0.60
MC1489	0.60
MC3446	2.50
MC3459	4.50
MCS3470	4.75
MC3480	8.50
MC3486	2.25
MC3487	2.25
MC4024	5.50
MC4044	5.50
MC6883	16.00
MC14411	7.50
MC14412	7.50
75107	0.90
75108	0.90
75109	1.20
75110	0.90
75112	1.60
75113	1.20
75114	1.40
75115	1.40
75121	1.40
75122	1.40
75150P	1.20

EPROMs

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75189	0.60
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75453	0.70
75454	0.70
75480	1.50
75491	0.65
75492	0.65
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8T28	1.20
8T95	1.20
8T96	1.20
8T97	1.20
8T98	1.20
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4.43MHz	1.00
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5

LIGHT METAL EFFECTS

BY ROBERT PENFOLD

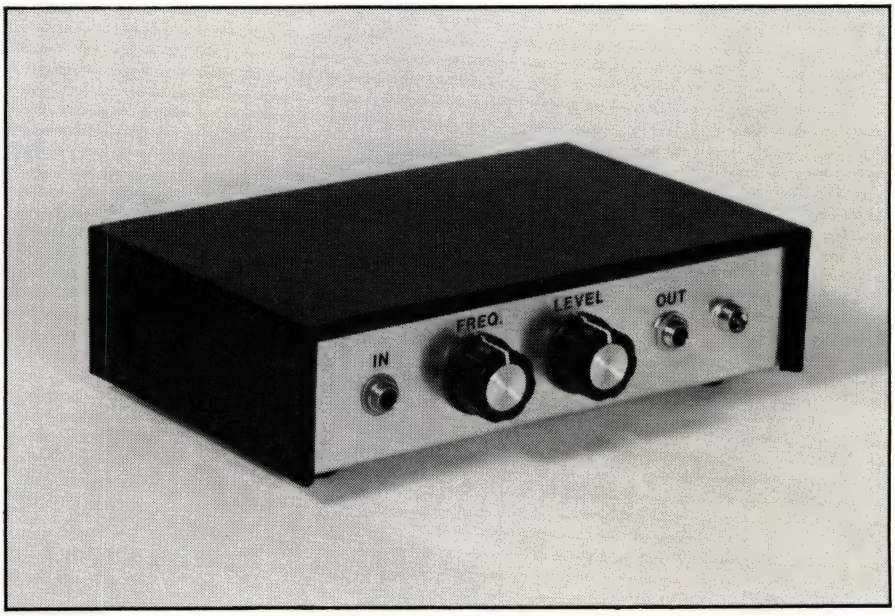
Lord of the rings?

Inspired by the former PE "Guitar Tracker", this project uses a vco and vca to produce a ring modulated sound which can be adjusted to follow the guitar's input at a chosen musical interval.

Probably most people who are "into" electronic music will be familiar with ring modulation, and its use in the production of metallic sounds (bells, gongs, etc.). A metal effects pedal is really just a ring modulator plus a built-in oscillator which is used to modulate the input signal. By setting the oscillator at a pitch which is a suitable musical interval from the input note, some quite harmonious metal sounds can be obtained. Unfortunately, a change in the input note will change the musical interval separating the two tones, and it may or may not produce a pleasant sounding output signal. For this reason the metal effect is generally used in moderation, or by those of more extreme musical tastes.

This unit was designed to overcome the rather hit and miss nature of the effect generated by a conventional ring modulator unit, and to give consistent results over a wide range of pitches. If you get a pleasant effect on one note from your guitar, then all the other notes should give more or less the same effect. What would I describe as a light metal effect rather than a heavy one. On the other hand, if you like the unharmonious sounds that can be produced by ring modulation, then the unit can be adjusted to give an equally discordant effect on every note (very heavy metal? – *For a **lead** guitar perhaps? Ed.)*

It operates in what is basically the same manner as a conventional metal pedal. The input signal is ring modulated by an oscillator, and the resultant signal is mixed with the unprocessed signal at the desired strength. The difference between this design and a conventional one is that the pitch of the oscillator is not set at some preset level, but automatically adjusted to match the input frequency. In other words, if the oscillator is set a fifth higher than the input at one input frequency, then it will automatically adjust its pitch on other notes so that it remains a fifth higher.



SYSTEMS OPERATION

The block diagram of Fig.1 shows the general arrangement used in the unit, and helps to explain the way in which it functions. The unit has similarities with the *"Guitar Tracker"* project described in PE June 1986, and it is a development of that project.

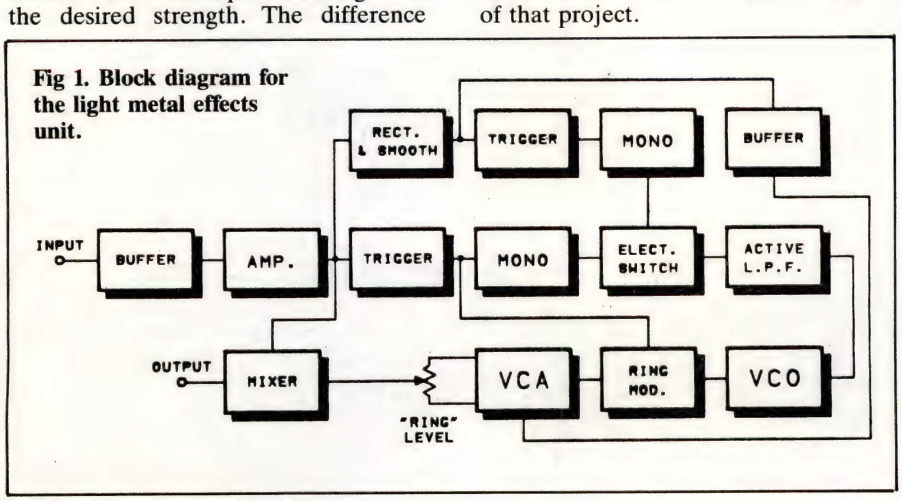


Fig 1. Block diagram for the light metal effects unit.

The input signal is taken to a buffer amplifier, and then to a voltage amplifier stage which ensures there is a high enough signal level to drive the subsequent stages properly. Some of the output from the amplifier is fed to a mixer stage and from here to the output socket. The output from the amplifier also drives a trigger circuit, and the roughly squarewave output signal from this circuit is split two ways. The first route is to one input of the ring modulator, where the signal is mixed with the signal from a vco (voltage controlled oscillator.).

The second route is to the input of a monostable multivibrator, and this acts as the basis of a simple frequency to voltage converter. The output pulse duration of the monostable is set by a CR timing circuit, and so the average output voltage depends on the number of times the monostable is triggered in a given period of time. The greater the number of times it is triggered, the higher the average output voltage. This may seem like a rather crude system of frequency to voltage conversion, which I suppose it is, but actually gives extremely good linearity. The output from the monstable is smoothed by an active lowpass filter to give a dc signal to control the vco The operating frequency of the vco is therefore moved up and down in sympathy with the pitch of the input signal.

There is a slight problem with this basic system in that it only provides a control voltage to the vco while an input signal at a reasonable level is present. Noises from the guitar if the fingering and playing is anything less than perfect can also give problems. To overcome these difficulties an electronic switch is used to connect the monostable to the lowpass filter for only a fraction of a second at the beginning of each new note. While this does not absolutely guarantee perfect results every time, it greatly reduces the risk of any mistracking. The lowpass filter is based on an ultra-high input impedance amplifier, and it therefore acts as a "hold" circuit which maintains the control voltage to the vco during the periods when the electronic switch is cut off.

to the mixer stage at the output, but this would not give entirely satisfactory results. The main problem is with breakthrough of the vco at the output of the ring modulator, but there is also a secondary problem in that the modulated signal is at a constant level, and does not vary in level in the same way as the input signal.

Both problems are overcome by feeding the ring modulated signal to the mixer by way of a vca (voltage controlled amplifier). This is driven from the output of the smoothing and recitifier circuit via a buffer amplifier. The amplitude of the ring modulated signal therefore varies in sympathy with the strength of the input signal.

The basic action of the ring modulator is to generate sum and difference frequencies from the input frequencies.

two or three dimensional in nature, and it is this that gives them the strong output at non-harmonic frequencies. They are effectively resonating at two or more frequencies, and interacting in a way that I suppose is roughly analogous to ring modulation.

THE CIRCUIT

Fig.2 shows the circuit diagram for the input, frequency to voltage conversion, and vco stages, while the rest of the circuit is shown in Fig.3.

I will not dwell on the operation of the circuit of Fig.2 here, since it is much as the equivalent stages in the *"Guitar Tracker"* project referred to earlier. Details of the way in which it functions can be found in this earlier article.

Turning our attention to Fig.3, IC7a acts as the basis of the ring modulator,

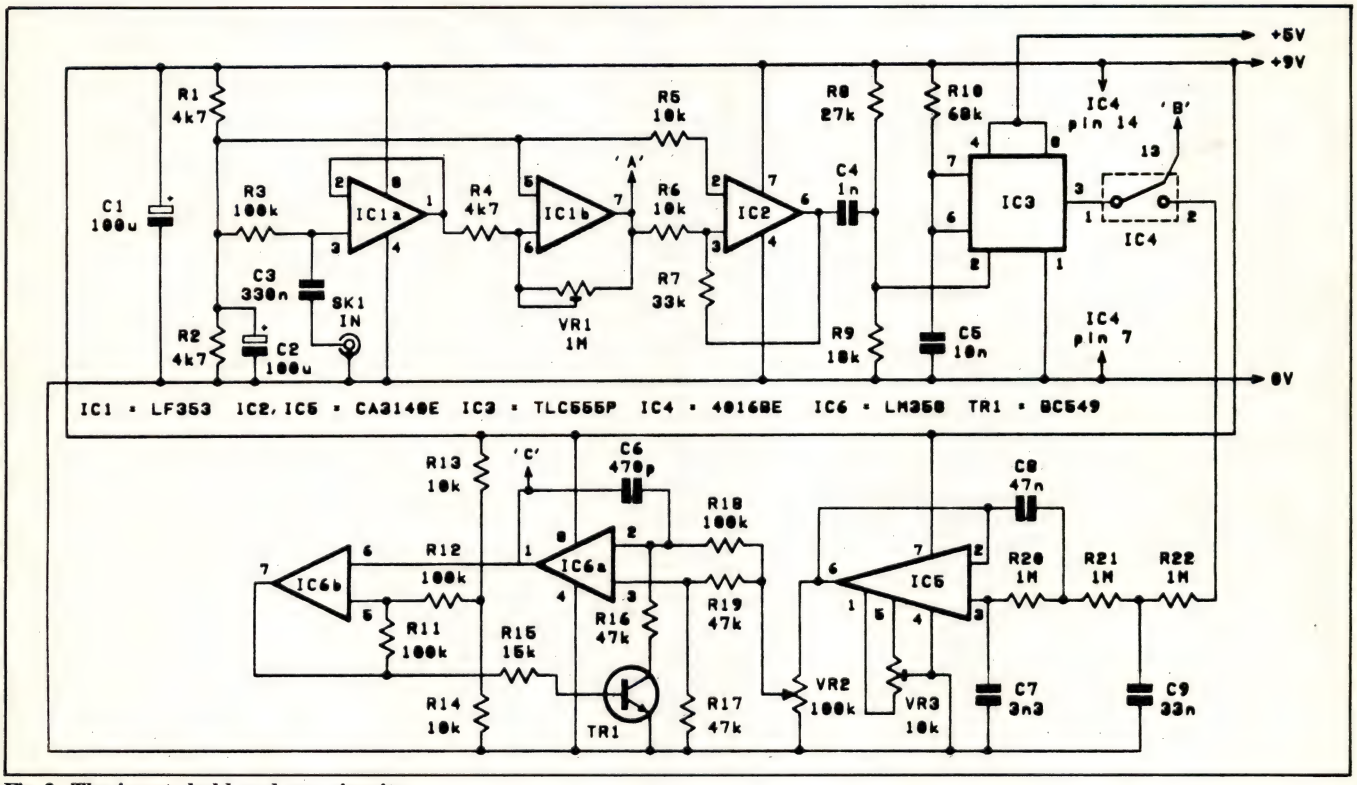


Fig 2. The input, hold and vco circuits.

The control signal for the switch is obtained by first rectifying and smoothing some of the output from the amplifier stage, so as to obtain a dc signal at a voltage which is proportional to the amplitude of the input signal. This dc signal is fed to a trigger circuit which is adjusted so that its output only triggers to the high state at the beginning of each note, when the signal from the guitar is at or close to its peak level. This gives a brief pulse which is used to trigger a monostable, and this circuit provides a gate pulse of suitable duration to the electronic switch.

This set up gives an oscillator which tracks up and down, following changes in the input frequency, and it ring modulates the vco's output with the input signal. The output from the ring modulator could simply be fed through

As a simple example, with the two inputs fed with frequencies at 400Hz and 600Hz the output frequencies would be 1kHz (400Hz plus 600Hz = 1000Hz or 1kHz) and 200Hz (600Hz − 400Hz = 200Hz). In theory the input signals are balanced out and do not appear at the output, although with practical circuits there is usually significant breakthrough of at least one of the signals, and at least slight breakthrough of both. The sounds that result from this form of modulation are metallic in character due to the output containing strong signals at non-harmonically related frequencies.

Most western instruments use strings or similar vibrators that are essentially one-dimensional, and this gives very little output at frequencies other than the fundamental and it harmonics. Metal instruments such as gongs and bells are

and this is one section of an LM13600N dual operational transconductance amplifier (ota). The signal from the vco is coupled to both the inverting input and the output of the ota, and this balances out the signal which consequently fails to appear at the output. The amplified guitar signal is fed to the control input of IC7a. It therefore varies the gain of this amplifier, giving only minor breakthrough at the output. This varying of the gain affects the cancelling of the vco signal at the output of the circuit, and provides the complex mixing needed to generate the sum and difference signals while suppressing the input signals. VR4 is adjusted to minimise breakthrough of the input signals at the output. The output is buffered by a built-in Darlington Pair emitter follower in IC7a.

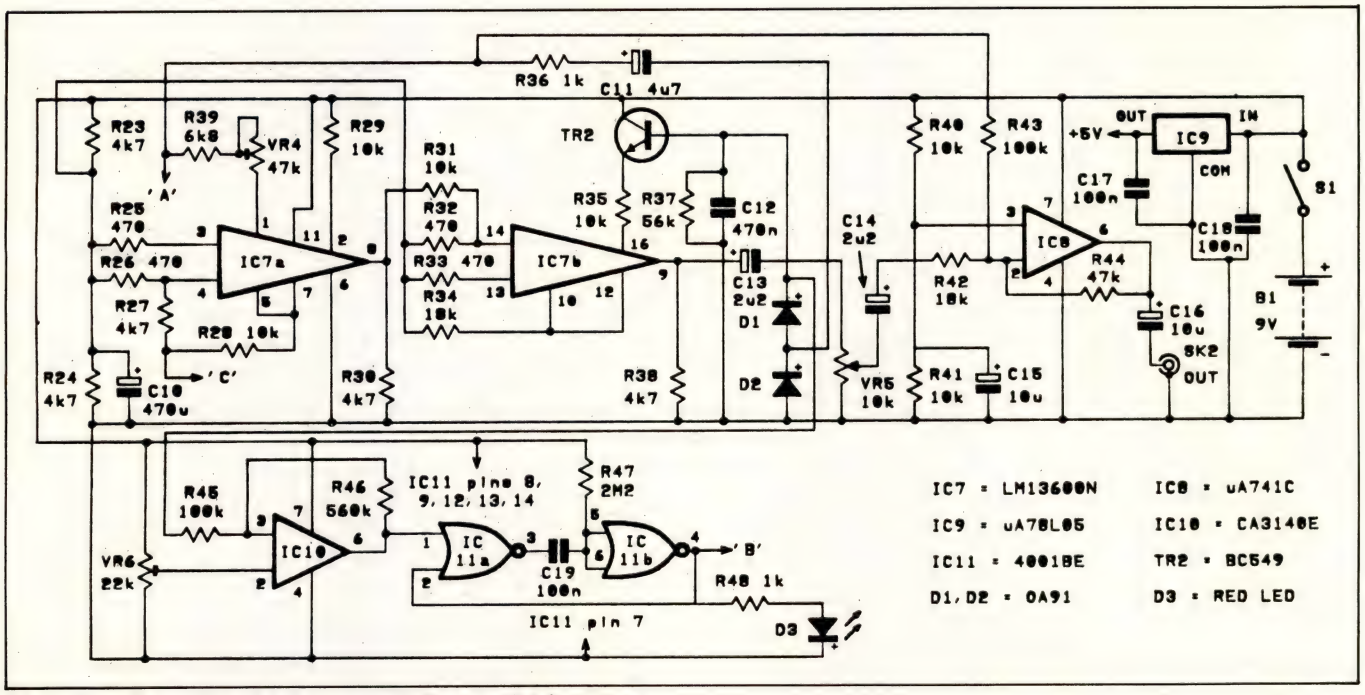


Fig 3. Circuit for the modulator, vca, trigger and mixer stages.

The other section of IC7 is utilised as the vca, and this is a conventional ota type. The amplified guitar signal is rectified and smoothed by D1, D2 and C12, and then fed to the control input of IC7a via buffer amplifier TR2. The envelope shaped output signal from IC7b is fed via level control VR5 to a conventional summing mode mixer circuit. Here it is combined with the amplified guitar signal in a standard summing mode mixer and then fed through to output socket SK2.

IC10 acts as the trigger circuit which is fed from the rectifier and smoothing stages. This is a simple operational amplifier type with the trigger level controlled using VR6 and a substantial amount of hysteresis provided by R46. The monostable is based on two of the cmos NOR gates in IC11, and it is a positive edge triggered, non-triggerable type. Note that the other two gates of IC11 are left unused, and their inputs are simply tied to the positive rail. Apart from driving the analogue gate, the output of the monostable also drives led indicator D3. This indicator is not much value in normal use, but it is helpful when initially testing and setting up the unit.

The unit is powered from a 9 volt battery, but the supply to the monostable in the voltage to frequency converter must be well stablised to avoid drift in the vco as the battery voltage falls due to ageing. The supply for the monostable is therefore derived through a 5 volt monolithic voltage regulator (IC9). The current consumption of the circuit is fairly high at around 20 to 25 milliamps, and the use of a medium or high capacity battery is recommended. I use six HP7 size cells in a plastic holder.

CONSTRUCTION

Refer to Fig. 4 for details of the printed circuit board. Several of the integrated circuits are mos types (IC2, IC4, IC5, IC10 and IC11) and require the normal anti-static handling precautions to be observed. It is probably best to use sockets for all the dil integrated circuits, mos types or not. Take care not to overheat D1 and D2 when soldering them into circuit as these are germanium devices. As such they are much more vulnerable to heat damage than are the more familiar silicon variety. A heat-shunt should not be necessary, but do not apply the iron to the joints for any longer than is really necessary.

Although an LM13600N is specified for IC7, some suppliers only seem to stock the virtually identical LM13700N. Either device should function properly in the IC7 position of this circuit. If the

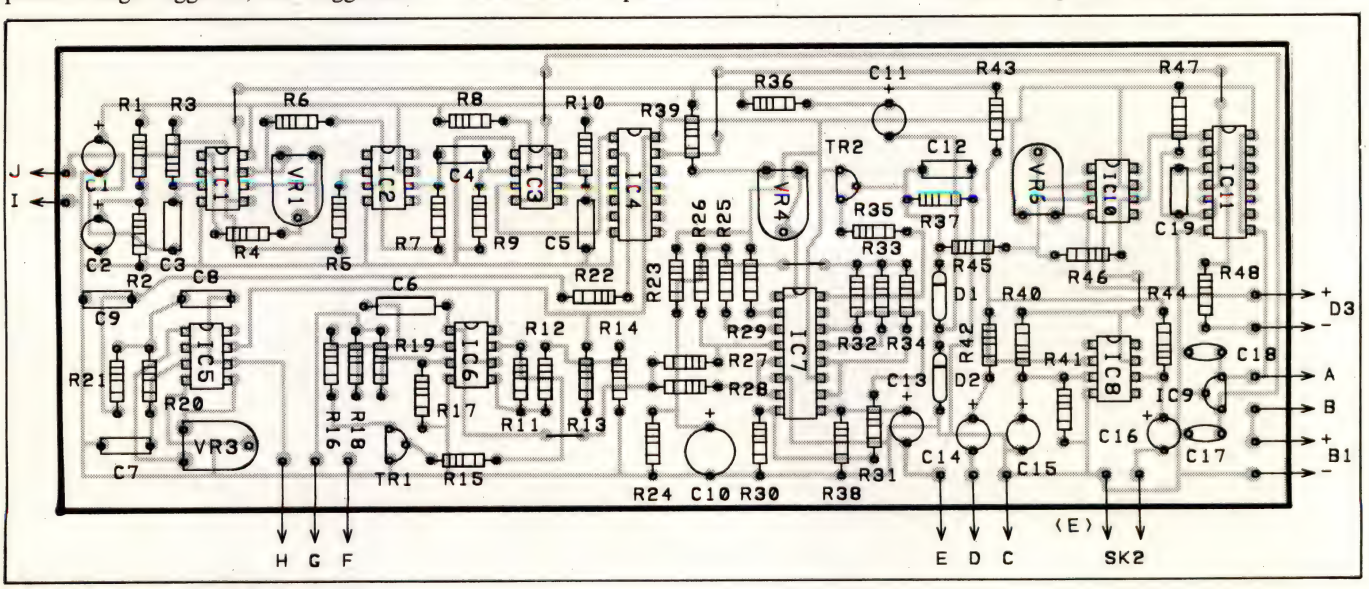


Fig 4. Printed circuit board details.

components are to fit onto the board easily it is essential to use modern miniature components, especially the capacitors which, with the only exception of C6, should be printed circuit mounting types.

I used a metal instrument case about 200 millimetres wide as the case for this project. The length of the printed circuit board and the need for a fairly large battery preclude the use of a case very much smaller than this. The controls, sockets, and led indicator are mounted in a row along the front panel, preferably in an arrangement which matches up well with the positioning of their connection points on the printed circuit board. SK1 should certainly be positioned close to its connections points on the board, or a screened lead should be used here. The printed circuit board should be positioned well towards the front of the case so as to leave sufficient space for the battery at the rear of the unit. Of course, the board must be mounted on stand-offs to keep the connections on the underside of the board well clear of the metal case.

On my prototype the on/off switch is a set of normally open contacts on the input socket (SK1). The unit is therefore switched on when the guitar lead is plugged into SK1, and switched off again when it is unplugged. This is quite common with effects units, and reduces the risk of the unit being accidentally left switched on. Presumably jack sockets will be used as the input and output connectors, and a socket of this type having a set of normally open contacts would not seem to be available. However, types with dpdt contacts are obtainable, and two contacts from one of these can be used to give the required switching action. Of course, it is quite in order to use an ordinary on/off switch such as a miniature spst toggle switch if preferred. The wiring to SK1 and the controls is shown in Fig.5 (which must be used in conjuction with Fig.4), and it is assumed here that a combined input socket and on/off switch are used.

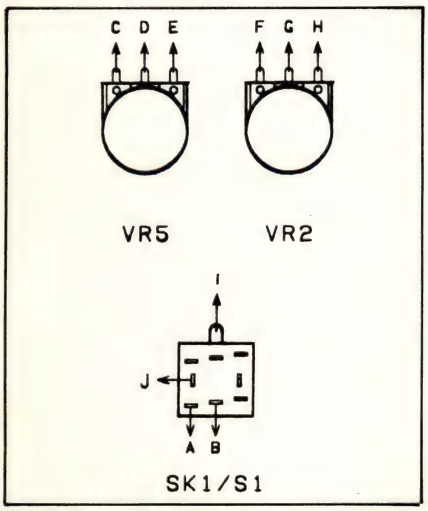


Fig 5. Control wiring

COMPONENTS

RESISTORS

R1,R2,R4, R23,R24,R27, R30,R38	4k7 (8 off)
R3,R11,R12, R18,R43,R45	100k (6 off)
R5,R6,R13, R14,R28,R29, R31,R35,R40, R41	10k (10 off)
R7	33k
R8	27k
R9,R34,R42	18k (3 off)
R10	68k
R15	15k
R16,R17,R19, R44	47k (4 off)
R20,R21,R22	1M (3 off)
R25,R26,R32, R33	470R (4 off)
R36,R48	1k (2 off)
R37	56k
R39	6k8
R46	560k
R47	2M2

POTENTIOMETERS

VR1	1M sub-min hor preset
VR2	100k lin
VR3	10k sub-min hor preset
VR4	47k sub-min hor preset
VR5	10k log
VR6	22k sub-min hor preset

CAPACITORS

C1,C2	100µ 10V radial elect (2 off)
C3	330n polyester layer
C4	1n polyester layer
C5	10n polyester layer
C6	470p polystyrene
C7	3n3 polyester layer
C8	47n polyester layer
C9	33n polyester layer
C10	470µ 10V radial elect
C11	4µ7 63V radial elect
C12	470n polyester layer
C13,C14	2µ2 63V radial elect (2 off)
C15,C16	10µ 25V radial elect (2 off)
C17,C18	100n ceramic (2 off)
C19	100n polyester layer

SEMICONDUCTORS

IC1	LF353
IC2,IC5,IC10	CA3140E (3 off)
IC3	TLC555P
IC4	4016BE or 4066BE
IC6	LM358
IC7	LM13600N or LM13700N
IC8	µA741C
IC9	µA78L05
IC11	4001BE
TR1,TR2	BC549 (2 off)
D1,D2	0A91 (2 off)
D3	Red panel led

ADJUSTMENT

There are four presets to be set up correctly before the unit is ready for use. VR1 must be adjusted to give a level of gain from the voltage amplifier that gives reliable triggering of the unit. It is a matter of using the lowest sensitivity (clockwise adjustment gives decreased sensitivity) that gives reliable triggering of the unit. Higher gain is undesirable as it could result in the signal being clipped at the output of IC1b, and it could also lead to spurious triggering of the unit.

VR3 is the offset null control for IC5, and it is adjusted to optimise tracking accuracy at low frequencies. The output tone from the vco needs to be monitored in order to do this, and something as basic as wiring a crystal earphone between IC6 pin 1 and the negative supply rail will suffice. It is a matter of first adjusting VR2 to match the vco frequency to the input frequency when using a high input frequency (ie about 1kHz). Then, using a much lower frequency (around 100Hz), adjust VR3 to match the pitch of the vco to the input note. Repeat this procedure a few times to get the tracking as accurate as possible. In this application very precise tracking is not really essential, and the setting of VR3 does not seem to be very critical.

The effect obtained varies somewhat with the setting of VR4. Although its main purpose is to minimise breakthrough of the vco and input signals, you can settle for any setting that gives an effect you like.

Initially VR6 should be set at about half maximum resistance, and the unit will probably work quite well at this setting. However, it is worthwhile experimenting with VR6 at slightly different settings, and readjusting VR1 to compensate, in order to find a combination that gives optimum results.

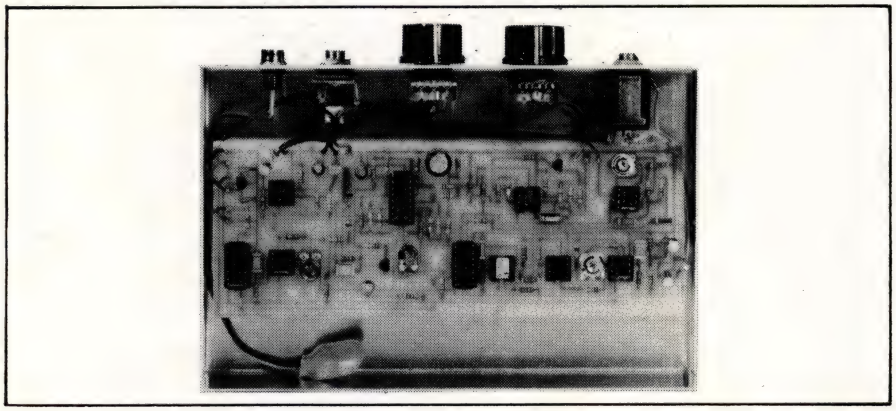
The unit produces some good "thicker" sounds, but to my ears anyway, it is at its best with VR5 set for a

MISCELLANEOUS

S1	Part of SK1
SK1	Standard jack with dpdt contacts
SK2	Standard jack socket
B1	9 volt (eg 6 x HP7 in holder)

Instrument case about 203 x 127 x 51mm, printed circuit board, battery connector, 8 pin dil ic holder (7 off), 14 pin dil holder (2 off) control knob (2 off), wire, solder, etc.

CONSTRUCTOR'S NOTE:
The PE PCB Service can supply the printed circuit board.



moderate amount of ring modulation. Remember that the signal from the modulator contains little output at the guitar frequency. Using a large amount of modulation you may find that the output notes are not the same as the ones you play on the guitar. As it stands the unit does not have any in/out switching. This could easily be added though, and all that is needed is a switch in series with C13 to cut the signal path of the modulation, or a switch to connect pin 16 of IC7 to earth and cut off the vca. An external foot-switch might be the best type of switch to use. PE

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−15V 1A	.39
−24V 1A	.39
+5V 0.1A	.28
+8V 0.1A	.28
+12V 0.1A	.28
+15V 0.1A	.36
−5V 0.1A	.30
−12V 0.1A	.30
−15V 0.1A	.30

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47µF 10V	.06
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47µF 35V	.08
47µF 63V	.08
47µF 100V	.17
10µF 35V	.06
10µF 63V	.06
22µF 100V	.21
100µF 10V	.06
100µF 16V	.06
100µF 25V	.07
100µF 35V	.08
100µF 50V	.19
100µF 63V	.21
220µF 10V	.06
330µF 16V	.19
470µF 16V	.25
470µF 50V	.40
470µF 63V	.63
1000µF 10V	.23
1000µF 16V	.27
2200µF 16V	.45

Axial Lead

4.7µF 63V	.06
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0.33µF 63V	.33
0.47µF 63V	.17

Disc ceramic

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220pF 50V	.05
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	Z84C-CTRL/B Cmos Built and Tested	£31.45

RS232 to Centronics Converter

This handy little interface is ideal for running parallel printers from a serial port, the low cost way out of buying expensive parallel ports for your computer. Originally designed for the Sinclair QL and Northstar Dimension in mind. The PCB measuring 60 × 62 comprises of the 6402 UART, Baud rate generator and all necessary logic, comes complete with wire and ribbon cable and 36W centronics plug. (For "D" Type connector and hoods see selection on left. Sinclair QL SER1 Plug available extra @ £1.68 order as 900-71052F)

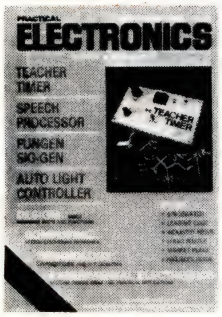
Order as:-	RS232-8/K Kit Form	£18.40
	RS232-8/B Built and Tested	£23.90

Distance Measuring Instrument

An invaluable handy instrument ideal for quickly measuring rooms no bigger than 50 feet sq. The ultransonic processing PTH PCB measuring only 77 × 85 has all the necessary components to output the distance in four digit BCD (multiplexed) reflecting either feet meters or yards selectable by a three position switch. The kit comes complete with Parabolic reflector and transducer. Available extra is a liquid crystal display board measuring 51 × 101 which can be wired to the BCD output to the above board directly to display the distance in 0.5 inch high digits.

Order as:-	UDM126/K Kit Form	£24.95
	UDM126/B Built and Tested	£34.95
	LCDM4/K LCD Kit Form	£14.30
	LCDM4/B LCD Built and Tested	£16.95

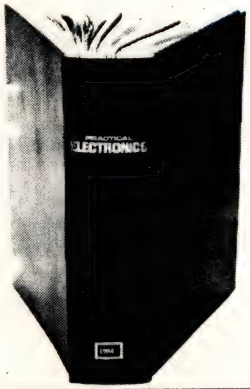
BACK NUMBERS, COPIES AND BINDERS



We can usually supply copies of back issue of PE up to three years old. These are £1.50 each including postage £2.00 for overseas readers). If we no longer have the issue needed, we will be pleased to send a photocopy of the article for the project that you want to build. These are £1.00 each per issue, including postage (£1.50 to overseas readers).

We also have the latest binders available for PE, each holding twelve issues. Embossed in gold with the PE logo, they will make a handsome addition to your technical library as well as keeping your magazines in mint condition. They are available at only £5.95 inc. p&p. (Overseas readers please add £2.)

REMEMBER SUBSCRIBING TO PE AVOIDS FUTURE DISAPPOINTMENT



£1 BAKERS DOZEN PACKS

Price per pack is **£1.00.*** Order 12 you may choose another free. Items marked (sh) are not new but guaranteed ok.

1 – 5 13 amp ring main junction boxes
2 – 5 13 amp ring main spur boxes
3 – 3 flush electrical switches
4 – 4in flex line switches with neons
5 – 2 80 watt brass cased elements
6 – 2 mains transformers with 6V 1A secondaries
7 – 2 mains transformers with 12V ½ A secondaries
8 – 1 extension speaker cabinet for 6½" speaker
9 – 5 octal bases for relays or valves
10 – 12 glass reed switches
11 – 4 OCP 70 photo transistors
12 – 4 tape heads, 2 record, 2 erase
13 – 1 ultrasonic transmitter and 1 ditto receiver
14 – 2 15000 mfd computer grade electrolytics
15 – 2 light dependent resistors
16 – 5 different micro switches
17 – 2 mains interference suppressors
18 – 2 25 watt crossover units 2 way
19 – 1 40 watt 3 way crossover unit
20 – 1 6 digit counter mains voltage
21 – 2 Nicad battery chargers
22 – 1 key switch with key
23 – 2 humidity switches
24 – 96 × 1 metre lengths colour-coded connecting wires
25 – 2 air spaced 2 gang tuning condensors
26 – 2 solid diaelectric 2 gang tuning condensors
27 – 10 compression trimmers
28 – 6 Rocker Switches 10 amp mains SPST
29 – 5 Rocker Switches 10 amp SPDT Centre Off
30 – 4 Rocker Switches 10 amp DPDT
31 – 1 24 hour time switch mains operated (s.h.)
32 – 1 6 hour clock timeswitch
33 – 2 6V operated reed switch relays
34 – 10 neon valves – make good night lights
35 – 2 × 12V DC or 24V AC, 4 CO relays
36 – 1 × 12V 2C O very sensitive relay
37 – 1 12V 4C relay
38 – 1 locking mechanism with 2 keys
39 – Miniature Uniselector with circuit for electric jigsaw
40 – 5 Dolls' House switches
41 – 5 ferrite rods 4" × 5/16" diameter aerials
42 – 4 ferrite slab aerials with L & M wave coils
43 – 4 200 ohm earpieces
44 – 1 Mullard thyristor trigger module
45 – 10 assorted knobs ¼ spindles
46 – 5 different themostats, mainly bi metal
47 – Magnetic brake – stops rotation instantly
48 – Low pressure 3 level switch
49 – 2 25 watt pots 8 ohm
50 – 2 25 watt pots 1000 ohm
51 – 4 wire wound pots – 18, 33, 50 and 100 ohm
52 – 4 3 watt wire wound pots 50 ohm
53 – 1 time reminder adjustable 1-60 mins
54 – 5.5 amp stud rectifiers 400V
55 – 1 mains shaded pole motor ¾" stack – ¼ shaft
56 – 2 5" ali fan blades fit ¼" shaft
57 – 2 3" plastic fan blades fit ¼" shaft
58 – Mains motor suitable for above blades
59 – 1 mains motor with gearbox 1 rev per 24 hours
60 – 2 mains motors with gearbox 16 rpm
61 – 4 11 pin moulded bases for relays
62 – 5 B7G valve bases
63 – 4 skirted B9A valve bases
64 – 1 thermostat for fridge
65 – 1 motorised stud switch (s.h.)
66 – 1 2½ hours delay switch
67 – 1 6v mains power supply unit
68 – 1 4½ V mains power supply unit
69 – 1 5 pin flex plug and panel socket
70 – 1 5" speaker size radio cabinet with handle
71 – 10¼" spindle type volume controls
72 – 10 slider type volume controls
73 – 1 heating pad 200 watts mains
74 – 1 1W amplifier Mullard 1172
75 – 1 Wall mounting thermostat 24V
76 – 1 Teak effect extension 5" speaker cabinet
77 – 2 p.c.b. with 2 amp full wave and 17 other recs
78 – 10 mtrs twin screened flex white p.v.c. outer
79 – 2 plastic boxes with windows, ideal for interrupted beam switch etc
80 – 3 varicap push button tuners with knobs
81 – 1 plastic box, sloping metal front, 16 × 95mm, average depth 45mm
82 – 2 speakers' 6" × 4" 15 ohm 5 watt made for Radiomobile
83 – 2 mains transformer 9V ½ A secondary split primary so OK also for 115V
84 – 2 6V 0.6V mains transformer .3a p.c.b. mounting
85 – 40 double pole leaf switches
86 – 1 7uf 660V 50hz metal cased condenser
87 – 2 2¼ in 60 ohm loudspeakers
88 – 2 2¼ in 8 ohm loudspeakers
89 – 1 mains operated relay with 2 sets c/o contacts
90 – 2 packets resin filler/sealer with cures
91 – 3 5A round 3 pin plugs will fit item 193
92 – 4 7 segment l.e.d. displays
93 – 4 pc boards for stripping, lots of valuable parts
94 – 4 1000uf 25V axial electrolytic capacitors
95 – 1 Audax PM 8" speaker 15 ohm 5 watt rating
96 – 100 4BA 1½" cheesehead plated screws and 100 4BA nuts
97 – 1 pair stereo tape head as in cassette recorder/players
98 – 1 bridge rectifier 600V international rectifier ref 3SB100
99 – 2 battery operated relays (3-6v) each with 5A c/o contacts 2 pairs
100 – 2 lithium 3V batteries (everlasting shelf life)

5 AMP BATTERY CHARGER KIT. ALL PARTS INCLUDING CASE ONLY £5.00 BUT ADD £1.00 P&P

OVER 400 GIFTS YOU CAN CHOOSE FROM

There is a total of over 400 packs in our Baker's dozen range and you become entitled to a free gift with each dozen packs.

A classified list of these packs and our latest "News Letter" will be enclosed with your goods, and you will automatically receive our next news leter

THIS MONTHS SNIP

3½ FLOPPY DISC DRIVES, made by the Chinon Company of Japan. Beautifully made and probably the most compact device of its kind as it weighs only 600g and measures only 104mm wide, 162mm deep and has a height of only 32mm, other features are high precision head position – single push loading and eject – direct drive brushless motor – Shugart compatible interface – standard connections – interchangeable with most other 3½ and 5½ drives. Brand new with copy of makers manual. Offered this month at £28.50 post and VAT included

CASE – adaptable for 3" or 3½" FDD, has room for power supply components price only £4 includes circuit of PSU. Our Ref 4P8.

POWER SUPPLY FOR FDD – 5V and 12V voltage regulated outputs, complete kit of parts will fit into case 4P8 price £8 or with case £11.

MULLARD UNILEX AMPLIFIERS

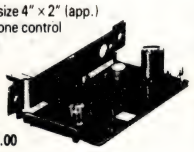
We are probably the only firm in the country with these now in stock. Although only four watts per channel, these give superb reproduction. We now offer the 4 Mullard modules – i.e. Mains power unit (EP9002) Pre amp module (EP9001) and two amplifier modules (EP9000) all for £6.00 plus £2 postage. For prices of modules bought separately see TWO POUNDERS.

CAR STARTER/CHARGER KIT

Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data case **£17.50 post £2.**

MINI MONO AMP on p.c.b. size 4" × 2" (app.)

Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of **£1.15 each, or £13 for £12.00**



LIGHT BOX

This when completed measures approximately 15" × 14". The light source is the Philips fluorescent 'W' tube. Above the light a sheet of fibreglass and through this should be sufficient light to enable you to follow the circuit on fibreglass PCBs. Price for the complete kit, that is the box, choke, starter, tube and switch, and fibreglass is £5 plus £2 post, order ref 5P69.

TANGENTIAL HEATERS

We again have very good stocks of these quiet runnng instant heat units. They require only a simple case, or could easily be fitted into the bottom of a kitchen unit or book case etc. At present we have stocks of 1.2kw, 2kw, 2.5kw, and 3kw. Prices are £5 each for the first 3, and £6.95 for the 3k. Add post £1.50 per heater if not collecting.
CONTROL SWITCH enabling full heat, half heat or cold blow, with connection diagram, 50p for 2kw, 75p for 3kw.

FANS & BLOWERS

5" £5 + £1.25 post. 6" £6 + £1.50 post
4" × 4" Muffin equipment cooling fan 115V £2.00
4" × 4" Muffin equipment cooling fan 230/240V £5.00
9" Extractor or blower 115V supplied with 230 to 115V adaptor £9.50 + £2 post.
All above are ex computers but guaranteed 12 months.
10" × 3" Tangential Blower. New. Very quiet – supplied with 230 to 115V adaptor on use two in series to give long blow £2.00 + £1.50 post or £4.00 + £2.00 post for two

9" MONITOR

Ideal to work with computer or video camera uses Philips black and white tube ref M24/306W. Which tube is implosion and X-Ray radiation protected. VDU is brand new and has a time base and EHT circuitry. Requires only a 16V dc supply to set it going. It's made up in a lacquered metal framework but has open sides so should be cased. The VDU comes complete with circuit diagram and has been line tested and has our six months guarantee. Offered at a lot less than some firms are asking for the tube alone, only £16 plus £5 post.

LOW COST OSCILLOSCOPE – kit to convert our 9" monitor into an oscilloscope with switched time bases to allow very high and very low frequency waveforms to be observed and measured. Signal amplitudes from as low as 10mV and as high as 1kV can easily be observed and measured. Ideal for servicing, also for investigating TV, radio and audio circuits.

Kit containing all the parts for the conversion and the power supply to operate from mains **£25** our ref 25P3.

TELEPHONE LEAD

3 mtrs long terminating one end with new BT, flat plug and the other end with 4 correctly coloured coded wires to fit to phone or appliance. Replaces the lead on old phone making it suitable for new BT socket. Price £1 ref BD552 or 3 for £2 ref 2P164.

COMPACT FLOPPY DISC DRIVE EME-101

The EME-101 drives a 3" disc of the new standard which despite its small size provides a capacity of 500k per disc, which is equivalent to the 3½" and 5¼" discs. We supply the Operators Manual and other information showing how to use this with popular computers: BBC, Spectrum, Amstrad etc. All at a special snip price of £27.50 including post and VAT. Data available separately £2, refundable if you purchase the drive.

POWERFUL IONISER

Generates approx. 10 times more IONS than the ETI and similar circuits. Will refresh your home, office, shop, work room etc. Makes you feel better and work harder – a complete mains operated kit, case included. £11.50 + £3 P&P.

J & N BULL ELECTRICAL

Dept. E.E., 250 PORTLAND ROAD, HOVE, BRIGHTON, SUSSEX BN3 5QT

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £20 add £1 service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted. Brighton (0273) 734648 or 203500.

NEW ITEMS

Some of the many described in our current list which you will receive with your parcel.

ASTEC T.S.U. Switch mode type so very compact. Normal 230V input. Has 3 outputs:– +5V at 3.5 amps, +12V at 1.5 amps and –5V at 0.3 amps. Should be ideal to drive floppy disc units. Regular price around £30, our price only £10 although brand new and unused. Order our ref 10P34.

POWERFUL 12V MOTOR was intended for the Sinclair electric car. Rated approx ½ hp. Our price only £15.00. Ref. 15P8.

BURGLAR ALARM BELL 6in. gong – ok to fix outside if sheltered from rain. Mains operated £8.00. Ref. 8P2.
12V battery operated £8.00. Ref. 8P2A

24 HOUR TIMESWITCH 16A C/O contacts, up to 6 on-offs per day. Nicely cased for wall-mounting. Price £8.00. Ref. 8P6.

CAPICITOR BARGAIN Axial ended 4700 uf at 25V. Superior Jap make, normally 50p each, you get 4 for £1.00 Ref. 613.

AGAIN AVAILABLE – 12" mini fluorescent tubes – Price £1 each. Ref. BD314.

POWER PACK OR AMPLIFIER CASE – Size approx 10" × 8¼" × 4¾" plated steel – with ample perforations for cooling. Front panel has on/off switch and E.E.C. mains inlet plug with built in RF filter – undoubtedly a very fine case which would cost at least £50 from regular sources, our price is £5 each and £3 post. Ref. 5P111.

MINIATURE BCD THUMB WHEEL SWITCH – Matt black edge switch engraved white on balck – gold plated, make before break contacts – size approx. 25mm high 8mm wide 20mm deep – made by the famous Cherry Company and designed for easy stacking – Price £1 each. Ref. BD601.

EDGE METER – miniature, whole size approxx 37mm × 13mm ua fsd – centre zero scaled 0 to –10 and 0 to +10. Price £1 each. Ref. BD602.

CLEANING FLUID – Extra good quality – intended for video and tape heads – regular price £1.50 per spray can – our Price – 2 cans for £1. Ref. BD604.

DON'T FREEZE UP! – We have had the strongest winds for over 200 years and who knows we may be in for the coldest winter, so if you have not already protected your water pipes you should do so now – our heating wire wound around the pipes will do this and will cost only about 50p per week to run – 15 metres (minimum length to connect to 230/240 v mains). Price £5. Our Ref. 5P 109.

PIEZO ELECTRIC FAN an unusual fan, more like the one used by Madame Butterfly, than the conventional type, it does not rotate. The air movement is caused by two vibrating arms. It is American made, mains operated, very economical and cause's no interference. So it is ideal for computer and instrument cooling. Price is only £1 each. Ref BD605.

SPRING LOADED TEST PRODS – heavy duty, made by the famous Bulgin company. Very good quality. Price four for £1. Ref. BD597.
CURLY LEAD four core, standard replacement for telephone handset, extends to nearly two metres. Price £1. each. Ref. BD599.

TELEPHONE BELLS – these will work off our standard mains through a transformer, but to sound exactly like a telephone, they then must be fed with 25 hz 50v. So with these bells we give a circuit for a suitable power supply. Price 2 bells for £1. Ref. BD600.

ULTRA SENSITIVE POCKET MULTIMETER – 4k ohms per volt – 11 ranges – carry one of these and so be always ready to test ac/dc volts to 1000, DC milliams and have an ohms range for circuit testing – will earn its cost in no time. Price only £7. Ref. 7P2.

BLOW YOUR ROOF OFF – 140 watt speaker systems – new type you must not hide! they have golden cones and golden surrounds and look rally "Bootiful" 12" Woofer, Midrange and Tweeter and comes with a crossover at a special introductory price of £49, carriage paid. Two sets for £95 carriage paid. 140w Woofer only £35 carriage paid.

3½ & 5¼ FLOPPY DISC DRIVES now in stock all are new and made by famous Epson company. All are double sided drives with storage capacity of 1 meg byte. They have standard connections and are fully compatible with conventional systems. Both are small size and light weight. Price – either model is £57.50 plus £3 post. Price includes copy operating data.

APPLIANCE THERMOSTATS – spindle adjust type suitable for convector heaters or similar price 2 for £1. Ref. BD582.

COMPUTERS

Big consignment of computers expected various makes and numbers, write or phone for details.

NOVEL NIGHT LIGHT – plugs into a 13A socket. Gives out a surprising amount of light, certainly enough to navigate along passages at night or to keep a nervous child happy. Very low consumption, probably not enough to move the meter. Price £1. Ref. BD563.
CASE WITH 13A PRONGS – to go into 13A socket, nice size and suitable for plenty of projects such as car battery trickle charger, speed controller, time switch, night light, noise suppressor, dimmers etc. Price – 2 for £1. Ref. BD565
SPEAKER EXTENSION CABLE – twin 0.7mm conductors so you can have long runs with minimum sound loss and for telephone extensions or burglar alarms, bells, intercoms etc. 250m coil only £3 plus £1 post. Ref. 3P28.
ALPHA-NUMERIC KEYBOARD – this keyboard has 73 keys with contactless capacitance switches giving long trouble free life and no contact bounce. The keys are arranged in two groups, the main area field is a QWERTY array and on the right is a 15 key number pad, board size is approx. 13" × 4" – brand new but offered at only a fraction of its cost namely £3, plus £1 post. Ref. 3P27.
TELEPHONE EXTENSIONS – it is now legal for you to undertake the wiring of telephone extensions. For this we can supply 4 core telephone cable, 100m coil £8.50. Extension BT sockets £2.95. Packet of 500 plastic headed staples £2. Dual adaptor for taking two appliances from one socket £3.95. Leads with B.T. plug for changing old phones. 3 for £2.
MODULAR SWITCH – Panel mounting highest quality and ideal where extra special front panel appearance is required, can be illuminated if required d.p.d.t. and latching. Price – 2 for £1. Ref. BD607.
WIRE BARGAIN – 500 metres 0.7mm solid copper tinned and p.v.c. covered. Only £3 + £1 post. Ref. 3P31 – that's well under 1p per metre, and this wire is ideal for push on connections.
INTERRUPTED BEAM KIT – this kit enables you to make a switch that will trigger when a steady beam of infra-red or ordinary light is broken. Main components – relay, photo transistor, resistors and caps etc. Circuit diagram but no case. Price £2. Ref. 2P15.
3-30V VARIABLE VOLTAGE POWER SUPPLY UNIT – with 1 amp DC output. Intended for use on the bench for experimenters, students, inventors, service engineers etc. This is probably the most important piece of equipment you can own. (After a multi range test meter). It gives a variable output from 3-30 volts and has an automatic short circuit and overload protection, which operates at 1.1 amp approximately. Other features are very low ripple output, a typical ripple is 3mV pk-pk, 1mV rms. Mounted in a metal fronted plastic case, this has a voltmeter on the front panel in addition to the output control knob and the output terminals. Price for complete kit with full instructions is £15. Ref. 15P7.
TRANSMITTER SURVEILLANCE (BUG) – tiny, easily hidden, but which will enable conversation to be picked up with FM radio. Can be housed in a matchbox, all electronic parts and circuit. Price £2. Ref. 2P52.

Half List Price — 6V 16 Ah Sealed Batteries

A sealed. maintenance free, lead acid gel battery, the EP6160 is manufactured by Elpower and delivers a massive 6 volt 16Ah capacity from a package measuring only 210 x 140 x 70mm. Useful for many standby or portable applications, the EP6160 is suitable for deep cycling use and is chargeable from a constant voltage source.

BRAND NEW ..... **£15** P&P £3.00

Easy Power — DC-DC Converters

Measuring only 85 x 70 x 20mm the **GSR407** converter delivers **7 Volts at 4 Amps** from an input range of 8-48 Volts DC. The use of modern switchmode circuitry enables an efficiency of **75%** and the unit is protected against short circuit and over-temperature. Simple to use, the GSR407 is offered with data sheet, and full application information is available.

BRAND NEW **£10**

Price Breakthrough! — 68000 Processors

The Signetics SCN68000 C8164 is an 8MHz 68000 cpu in a 64 pin Ceramic DIL package. Due to its advanced design features the 6800 has become an industry standard in true 16 bit processing. A scoop purchase enables us to offer this popular device at the unbelievable price of

MASSIVE STOCKS
MUST BE CLEARED ..... **£5** P&P £1.00

SIEMENS V30141 300 WATT OPEN FRAME SWITCHMODE

A high reliability multirail supply carrying UL and CSA approvals. Built on a rugged aluminium chassis the V30141 accepts 110 or 220Vac input and delivers five outputs: * 5V/35A * 12V/3A * 24V/3.2A * −12V/0.2A * − 5V/2A

All units burned in and tested
Offered BRAND NEW & boxed
Overall size 390 x 225 x 70mm

REDUCED TO CLEAR only **£30** + VAT + £2 P&P

SUPER SAVINGS ON SWITCHMODES

£20 only +£2 P&P

GRESHAM LION SWITCHMODE TRIPLE RAIL SUPPLIES

Top quality power supplies originally manufactured for a major OEM. Three outputs on 0.156 moles connector +5V at 6 Amps * +12V at 4.75 Amps − *12V at 0.5 Amps. Semi enclosed in an attractive black enclosure,m the units are supplied BRAND NEW with data. Input 240 Vac on switched IEC skt.

Mitsibushi disk drives model 4853.
80 track double-sided, double density. **£60** each inc VAT P&P £3

DECEMBER SPECIAL OFFERS

BBC DISK INTERFACE leads, 34 way speed-bloc socket to 34 way connector. Available in single or twin drive configurations.
SINGLE DRIVE . . . £1.50 TWIN DRIVE . . . £2.50

UM 1286 modulators · High quality UHF modulcators for interface of computer and video 75 Ohm sources to TV sets. Data supplied.
BARGAIN PRICE £4.00

ELMA INSTRUMENT CASES – Supplied in kit form, these attractive and easy to assemble enclosures are finished in Pacific Blue and will accept either Eurocards or modular components.
Size 317 x 140 x 240mm ONLY £10.00

NEC MC5808 DBS Local Oscillator Module 10GHz ECS frequency, 50ohm o/p £15.00

LITHIUM CELLS, Matsushita BR 2325, 3V, 23 x 3mm . £1.50

PAPST Fans – Type 4850 120mm low noise axial fans. 240V Brand New £7.00

SPRITE FANS – 80mm low noise axial fans high performance. 240V NEW £6.00

FADERS – Metal body construction.
10K Lin 60mm Mono £0.60
10 K Lin 45mm Mono centre stop £0.60
100K Lin 45mm Ster centre stop £1.00

Semiconductors

Part No.	Mfr	Description	Price
DAC80-CBI-V	B Br	12 Bit D-A Converter	£4.00
K1135A	Mota	Dual Baud Rate Gen	£2.00
AY-3-1270	G.I.	Temperature Controller	£2.00
LD271	Siem	I-Red Emitter 950nm	£0.10
BPX81-IV	Siem	Phototransistor 850nm	£0.10
DL1416	Nat	Intelligent 4 Chr Ascii Display	£6.00
MAB8031AH-12P	Sig	8 Bit Microcontroller	£3.95
LM350K	Mota	Adj: 3A Regulator TO3	£2.00
INS815-4N	Nat	16 Bit I/O + 256 Bit RAM	£6.00
D8755A	Int	I/O Port + EPROM	£7.00
80188	AMD	8 Bit High integration CPU	£20.00
2N6282	RCA	20A Dartington · House coded	£0.50

Quantity discounts available on all the above lines.

Switchmode Power Supplies

GOULD MGS-20, 5V at 20A £20.00
GOULD MGS-40, 5V at 40A £35.00
GOULD MGS-60, 5V at 60A £45.00
GOULD MMGS-5, 5V at 5A £15.00
ASTEC Power supplies 65 watt, brand new, 110/240V input, outputs +5V at 6 amps, +12V at 2.1 amps, +12 at 1.5 amps, −12 at 250 Ma. Size 196mm × 96mm × 45mm. ..... Price £20.00
POWER GENERAL 4100. 5V at 20A. ±12V at 1A. −5V at 1A. plus £2.00 p&p
Supplied brand new & boxed with data sheet £25.00
LAMBDA LWT-1B. 5V at 1A. ±12V at 1A. Brand new miniature FET switcher, size 110 x 50 c 35mm. Only £15.00
FARNELL N200. 5V at 30A. ±12 V at 5A. Few only £35.00
Other switchers always in stock. Please phone for sales or technical information on our wide range.
FARNELL G30. 5V at 5A or 15V at 2A, two versions £20.00

Rechargeable Batteries

A range of YUASA maintenance free rechargeable Lead Acid batteries having many applications in portable and standby situations. Suitable for cyclic and standby use the sealed construction ensures long life and no electrolyte leakage. All batteries are brand new and available ex-stock at highly competitive prices.

*6 Volt 1Ah	£5.50	*12 Volt 1.2Ah	£10.00
*6 Volt 1.2Ah	£7.25	*12 Volt 1.9Ah	£13.00
*6 Volt 2.6Ah	£8.00	*12 Volt 2.6Ah	£15.00
*12 Volt 6AH	£20.00	all prices +P&P	

Linear Power Supplies

ELPAC SOLV 30. 12V at 4A Open frame supply.
Brand new and boxed with data sheets £15.00
ADVANCE PMG5-5. 5V at 5A £20.00
ADVANCE PMG12-1.2. ±12V at 1.2A £25.00
ADVANCE PMGD15-1.2. ±15V at 1.2A £25.00
ADVANCE PMA47. Variable 0-15V at 3A £20.00
ADVANCE PMA 48. Variable 0-30V at 3A £25.00
COUTANT ESM15. 5V at 15A. ±12V at 1.5A. 12/24V at 2A £40.00

CAPACITORS

2μF 250Vac Filmcap ACT Polycarbonate	£1.00		
100/350V Erie KB411CT	£1.00	470/250V Mull 0.52	£0.80
2200/16V Rad. Panasonic	£0.25	2200/63V ITT KS10A	£1.00
2200/200V Mallory CGS	£2.00	3300/50V Marcon CGF	£0.50
4700/16V Ax.Mull 032	£0.25	4700/25V Mull 050	£0.50
4700/63V Procond 542	£1.10	10000/16V Rad Nich	£0.30

We carry a full range of Ceramic, Poylester, Polystyrene, Tantalum, Electrolytic, Variable and Trimmer capacitors.

Motors

SANYO 103-606-2 Stepper. 2 Phase 4 pole 6V 3A £10.00
SHINKOH 20PMA055 Stepper. 1 Phase 3 pole 28V 1.3A £10.00
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14Vdc Step Angle 7.5 Deg. 27.5 Ohms/Coil £10.00
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PART TWO BY MIKE SANDERS

INTELSAT V DOUBLES ITS MONEY

The pressures on comms satellite capacity is increasing steadily. Several ways of routing a greater number of signals have been worked out, including on-demand assignment, multiple accessing, higher-frequency bandwidths and carrier repolarisation.

Single channel per carrier, pulse code modulation, multiple access, demand assignment (spade) operations were begun in 1974 by twenty earth stations.

Let us take the definition a bit at a time. Single channel per carrier does not mean only one speech channel but a whole lot ranging from 24 to 960 channels. One of these 'lots' then constitutes a channel on the satellite link. The term channel often refers to different bandwidths and is an often abused word. Carriers with speech channel capacities ranging from 24 to 960 will have bandwidths of 2.5MHz, 5MHz, 7.5MHz, 10MHz, 20MHz, 25MHz, 35MHz. It can be seen that the largest, 35MHz, occupies a whole transponder of 36MHz.

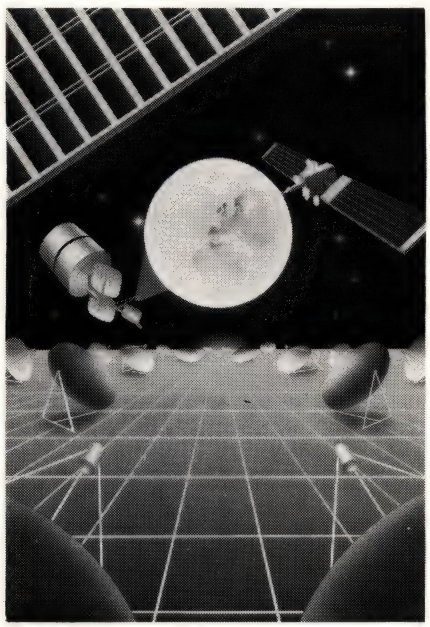
Pulse code modulation refers to the well known pcm technique of converting analogue signals into digital signals. Multiple access means that more than one earth station can access the satellite as for a frequency division multiplexed system. The interesting bit is the demand assignment and an earth station is assigned a carrier only when it actually wants to transmit and not on a permanent basis.

SPADE WORK

So what is the attraction of spade operation? If an earth station can access a satellite only when it has a message to transmit, then small countries with light traffic do not have to tie up satellite capacity as with pre-assigned fdm. However, spade equipment is expensive and operates as follows.

All the signalling information (routing digits, duration of call etc) is separated from the message (speech or data) at the earth station terrestrial interface unit (tiu) before transmission. This signalling information is then conveyed over common signalling channels (csc) between up to 50 earth stations. These signalling channels are not assigned by demand but open all the time. This is because no breaks can be tolerated in the csc links, since the telephone exchanges must know how to route the call even before the speech arrives. Also, csc operating at 128 kbit/s is used by each earth station to keep in touch with the controlling earth station.

At the terrestrial interface unit, the speech is also converted to digital form by pcm. At the earth station both



received speech and signalling are converted back to analogue form since, at the present time, terrestrial networks are mainly analogue.

At the heart of spade operation is a demand assignment signalling and switching equipment (dass) which controls the setting up of calls. One earth station must act as control and transmit a reference burst. All other stations then transmit their bursts in an allotted time window in relation to the reference burst (Fig.1.)

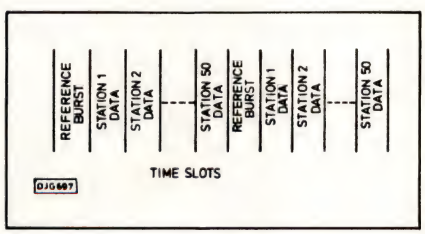


Fig 1. *Spade operation*

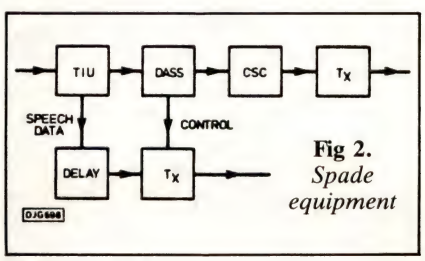


Fig 2. *Spade equipment*

Each time a request is received for a call, the relevant dass selects a pair of transmit/receive carriers and informs the distant earth station. Such communication is carried out via the csc, Fig.2. Also, all dass units are aware of which carriers are free at any given moment. In addition dass can log the duration of a call as well as any faults occurring.

Let us see how many spade channels a transponder can support. We have seen how a 4KHz speech channel when frequency modulated occupies 45KHz of bandwidth. Therefore a 36 MHz transponder will accommodate 800 speech channels. If these channels were in continuous operation, the transponder would be able to supply the power requirement of only half this number, ie 400 channels. But a speech channel is in use for only 40% of the time: only one party speaks plus gaps in conversation, therefore the transponder can manage 800 channels.

SINGLE CHANNEL CARRIER

Four years after spade operations started, there was such a heavy demand for data circuits building up, that single channel per carrier (scpc) was introduced. There are several small countries with only half a dozen circuits to the UK, four of which could be speech and two data circuits.

Scpc is essentially the same as spade, except that the link is pre-assigned and available for use whenever the customer desires. Just as with spade, the carrier is switched on whenever there is a voice transmission, and to avoid losing the leading edge of the spoken word, a delay line is used, Fig.3. This delays the speech for a few milliseconds while the carriers are enabled.

For data at 48kbit/s, 50kbit/s and 56kbit/s there is no point in switching the carriers on and off and therefore the

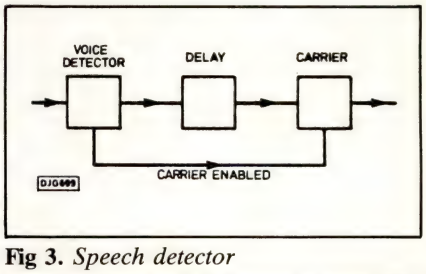


Fig 3. *Speech detector*

speech detector is disabled. Lower data speeds of 1.2kbit/s, 2.4kbit/s and 4.8kbit/s can be multiplexed to give a higher speed. There are also intermediate rates of 9.6kbit/s and 19.2kbit/s for facsimile as well as data transmission.

An increasing use of transponders for data transmission means that each transponder can handle fewer than 800 channels, or the power of each transponder must be increased. If there is a heavy demand for scpc, four transponders on Intelsat IV an IVA can be switched from global to spot beam by ground telemetry. This is the kind of remote control that will be built increasingly into future satellites.

The greater the number of carriers, the more the frequency deviation has to be reduced. In an fdm system using 10 to 20 carriers, a frequency deviation of around 80kHz is good enough. But when there could be as many as 800 carriers on each transponder when used for scpc, then the frequency deviation of the carriers must be reduced to 250Hz to prevent one carrier interfering with its neighbours.

ERROR CHECKING

We have seen from Fig.1. how one station acts as a control and transmits a reference signal. This reference signal or pilot is used by the other earth stations for gain as well as frequency control. Then each station transmits its own burst in its given time window. Apart from containing the message being transmitted, each burst contains header information like station identification and synchronisation words.

As scpc was bascially set up to cope with the increased transmission of data, we cannot leave the topic before considering some means of error correction. Forward error correction (fec) is obtained by converting the bit stream into three paths say a, b, c as in Fig.4. Parity can be even or odd. Parity is said to be even when the sum of all the digits including the parity bit is even. Similarly, odd parity can be generated.

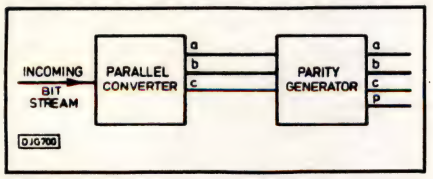


Fig 4. *Forward error correction*

Once the parity mode has been decided then any deviation from this is an error and the receiver can request a retransmission. The above method of taking three streams and converting to four is called rate ¾ encoding and provides a bit error rate (ber) of 1 in 10^7 which is desirable for data transmission. Rate ⅞ encoding is also used and the principle is the same as the above, ie one parity stream is provided for seven data streams.

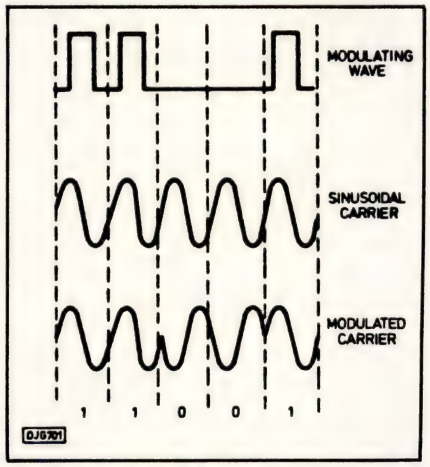


Fig 5. *Phase shift keying*

Now that we have generated four bit streams some means must be found of transmitting them. Quadrature phase shift keying, qpsk or 4psk, is a popular method for doing this and 8psk is used for the ⅞ encoder. A simple explanation of phase shift keying is shown in Fig.5, where an analogue waveform is coded to represent a digital stream. Any change in binary digits from 1 to 0 or vice versa is represented by a phase shift of the analogue wave.

In the same way, the phase of the carrier is shifted in qpsk so that one can tell which bit stream is being transmitted. Two 2-phase modulators are used as shown in Fig.6a and the 46MHz carrier is used to alter phase as shown in the phasor diagram of Fig.6b.

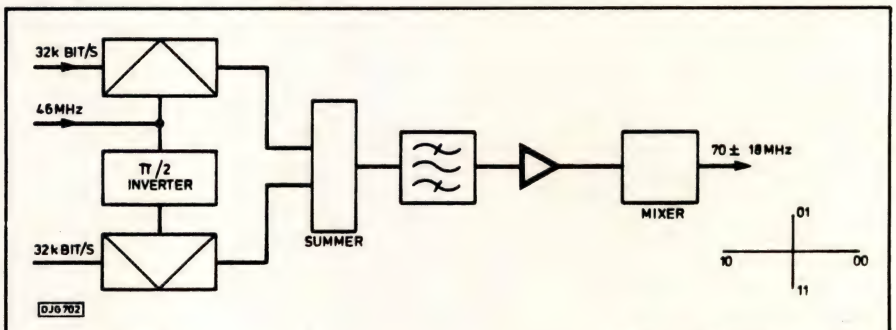


Fig 6a. *QPSK*

Fig 6b. *Phasor diagram*

INTELSAT V

After Intelsat IV, came ... you've guessed it, Intelsat V and these are the current breed of communications satellite. Intelsat V was launched in 1980 with a shape slightly different from earlier satellites, Fig.7. Instead of housing the solar cells on the cylindrical body, they were placed on flat panels.

Intelsat V has double the capacity of Intelsat IVA, ie 25,000 voice channels compared to 11,000 for Intelsat IVA. What is more, satellite capacities have more or less kept pace with the transatlantic (tat) cables with around 400 channels in 1968, followed by 3000 channels in 1969 and 8000 channels in 1977. Two channels, that is transmit and receive, equal one circuit.

Each time a new generation of satellite goes for greater capacity there are two problems to be overcome: the search for bandwidth and the power to operate this bandwidth. Intelsat V solved the problem of increased bandwidth by operating in the 14/11GHz range as well as in the 6/4GHz. In addition each of these carriers can be re-used if polarised. Increased power is obtained by placing the solar cells on large flat panels since placing them on a cylindrical shape puts half of them in the dark.

MULTIPLE CAPACITY

But to return to polarisation, an electromagnetic wave travelling in a waveguide consists of an electric field perpendicular to a magnetic field, Fig.8. Placing a sheet of dielectric material within the waveguide changes the direction of the field so that the electric field is now vertical and the magnetic field horizontal. These are called horizontal and vertical polarisations and straight away we have doubled the capacity of a single carrier.

But that is not all; we can also polarise a waveform in a circular fashion providing either clockwise or anticlockwise fields called right hand circular (rhc) and left hand circular (lhc), Fig.9. So using the same carrier with both linear as well as circular polarisations has quadrupled the traffic carrying capacity.

There must be 30dB separation between polarisations in order to

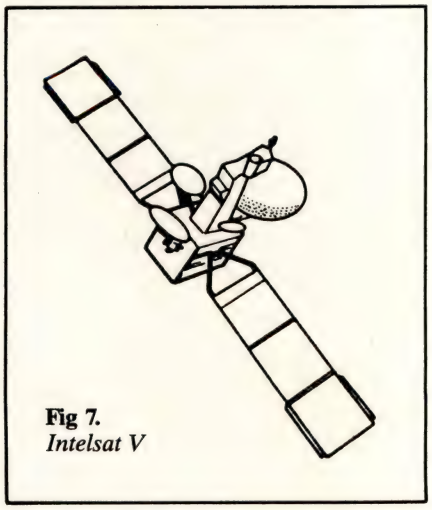


Fig 7. *Intelsat V*

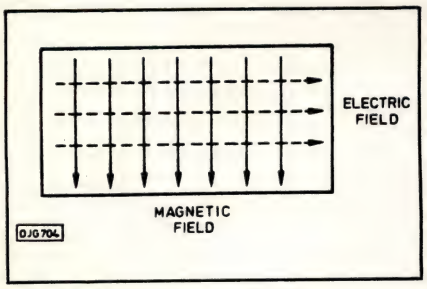


Fig 8. *Electromagnetic fields*

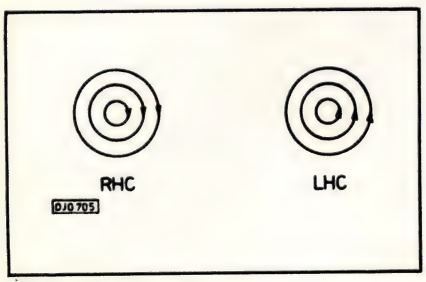


Fig 9. *Circular polarisation*

prevent beams from interfering with each other and there are four types of beam. A global beam, as its name implies, covers whatever area of the earth is visible, a spot beam concentrates on areas of high traffic, and zone and hemispheric beams cover slightly larger areas as shown in Fig.10.

The combinations of frequency and polarisation is shown in Table 1.

In order to produce the complex patterns shown in Fig.10, the aerial reflector has 88 feeds, Fig.11a. But many feeds would block the reflector so an offset feed is used as in Fig.11b. The reflectors have less room for movement compared to the global horns and all are steered by ground command.

The gain of each type of beam is stated as if the beam were being radiated in all directions, eg a light bulb. These gains are 35 dBi for the spot beam, 23dBi for the zone beam and 17dBi for the global beam (i = isotropic radiator).

CIRCUIT MULTIPLICATION

We have seen how a satellite is put under pressure to provide power during

BEAM	FREQUENCY	TRANSMIT POLARISATION	RECEIVE POLARISATION
Global	6/4 GHz	RHC	LHC
East Hemi	6/4 GHz	RHC	LHC
West Hemi	6/4 GHz	RHC	LHC
East Zone	6/4 GHz	LHC	RHC
West Zone	6/4 GHz	LHC	RHC
East Spot	14/11 GHz	Linear	Linear
West Spot	14/11 GHz	Linear	Linear

TABLE 1

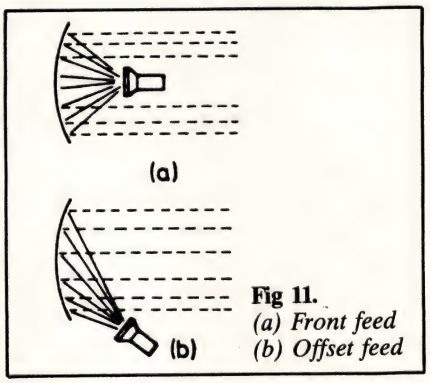


Fig 11. *(a) Front feed (b) Offset feed*

data transmission compared to speech transmission. However, administrations who have paid for satellite capacity tend to use that capacity to the maximum. In a speech circuit only one channel is utilised since only one person speaks at any one time and taking pauses into account, the usage of each circuit (two channels) is only about 40%. Therefore using circuit multiplication equipment the usage of a satellite link can be easily doubled. Such equipment already exists and puts further demands on satellite power.

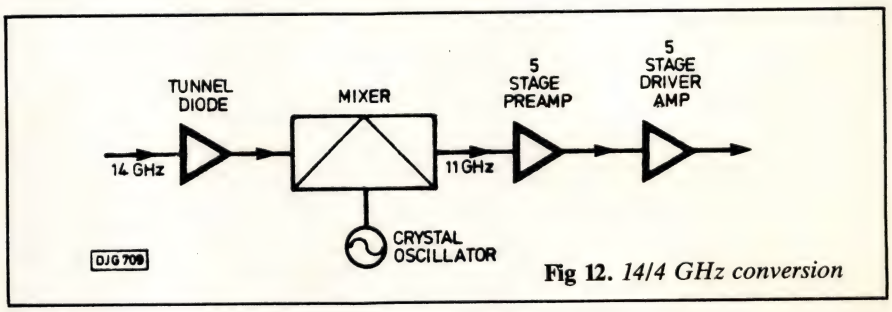


Fig 12. *14/4 GHz conversion*

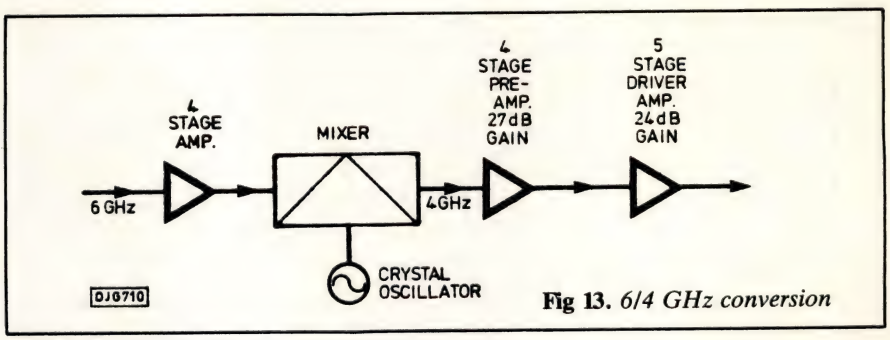


Fig 13. *6/4 GHz conversion*

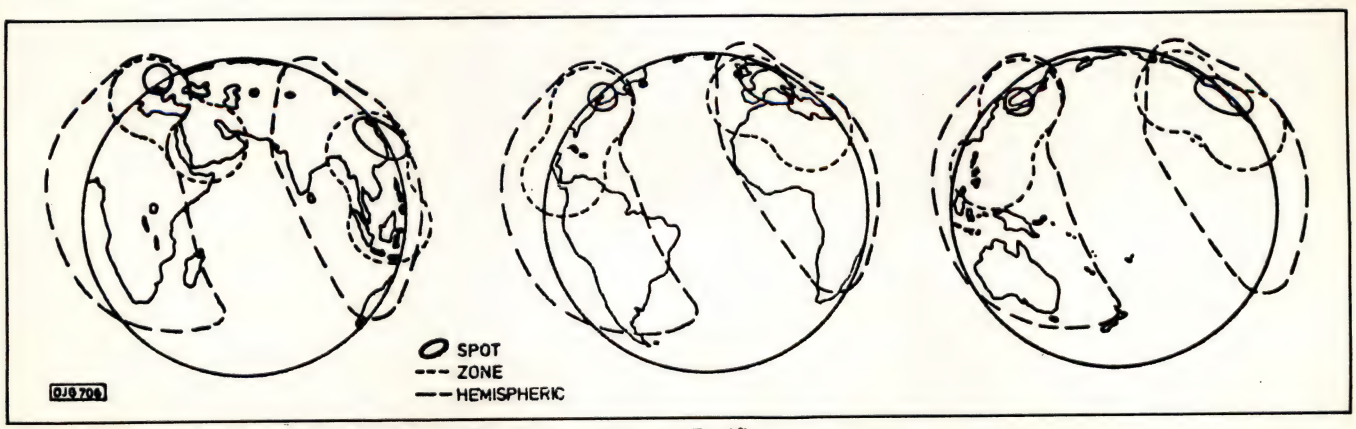
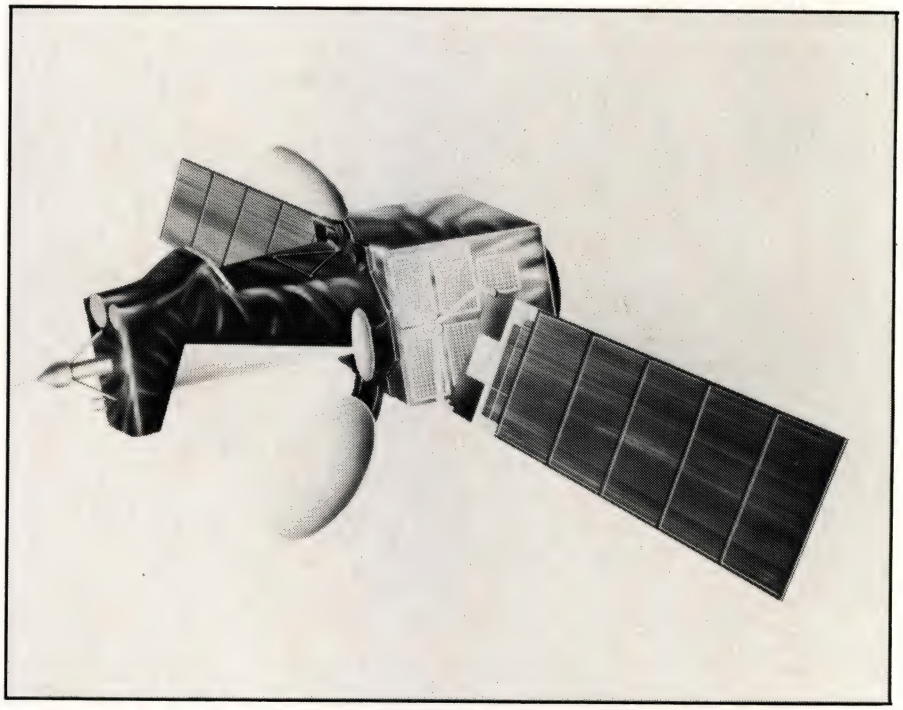


Fig 10. *Intelsat V coverage. Left to right: Indian Ocean, Atlantic, Pacific.*

The transponders on Intelsat V have double the bandwidth of Intelsat IV transponders, ie 72MHz compared to 36MHz. Since signals are received at the satellite at both 14GHz, and 6GHz, these are converted to 4GHz to keep matters simple and assist signal processing.

Each of the spot beams at 14GHz has two receivers (working and a standby). The receiver consists of a germanium tunnel diode coupled into a Schottky-diode mixer, fed by a crystal oscillator, Fig.12. This is followed by a 5-stage preamplifier and 5-stage driver amplifier.

The 6GHz is treated in much the same fashion, Fig.13, with amplification via a 4-stage amplifier employing bipolar silicon transistors. After the mixer, the 4GHz goes through a 4-stage preamplifier and a 5-stage driver amplifier, giving a total gain of 51dB. There is a gain adjustment of 7.5dB which can be switched in or out from earth. So the telemetry commands are not only for altering the position of the satellite and wiggling the aerial dishes but also for switching between transponders and altering the gains slightly. At 11GHz, waveguide switches are used but at 4GHz coax switches are adequate.



Intelsat V. Photo reproduced by kind permission of British Telecommunications plc

RECEIVERS

There are five receivers to cater for the global beam, the east and west hemispheric beams, the east and west zone beams. All these are on the 6/4 GHz path and there are six standby receivers. As in Fig.12 and 13 each receiver is a low noise amplifier, mixer and several stages of amplification. The 6/4 GHz path uses separate aerials for the transmit and receive directions but the same aerial for transmit and receive on the 14/11 GHz path.

After the receiver, the signal is filtered. We have seen how the guard band was cut down from 70% to 10% in designing Intelsat IV. With even more circuits on Intelsat V there is a need to keep guard bands to the minimum. There are 60 filters made of graphite fibre reinforced plastic (gfrp). This material is lighter than invar which was used in earlier filter design. The Q of a filter is a figure of merit, the larger the Q, the sharper the filter, Fig.14. The Q of such filters is typically 10,000 and the filtering is so good that there is no need to divert the odd channels to a separate aerial from the even channels. The latter tactic was employed on Intelsat IV in order to relax the limits on filter design.

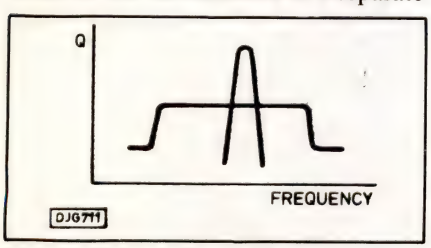


Fig 14. *High and low Q filters*

TRANSMISSION

Having received the signal and processed it as described above, the satellite now prepares to transmit. All 4GHz signals destined for 4GHz paths are at the correct frequency, but those 4GHz signals destined for 11GHz paths are up-converted.

The final amplification for spot and global beams is via travelling wave tubes (twts) providing 8.5W for the hemispheric beams and 4.5W for the zone beams (both at 4GHz). At 11GHz (spot beam) the power is 10W. Global and spot beams have one standby twt for every one in use and the other beams have two standby for every three in service.

The aerial tower and dishes are made of gfrp. This material, in addition to being light, is stronger than other alloys used in aviation. Also, gfrp has a low temperature coefficient, ie the expansion with temperature increase is low. This is a useful feature since the difference in temperature between the sunny side and the dark side of a satellite is easily a couple of hundred degrees celsius. The aerials are folded before launch and deployed only when the satellite has reached its final orbital position.

STABILISING

We have seen how previous satellites were stablilised by an internal spinning. Intelsat V also has a wheel spinning at 3500 rpm, and a standby wheel, each weighing 15kg. The main difference is that Intelsat V is stabilised in all three planes: pitch, roll and yaw, Fig.15.

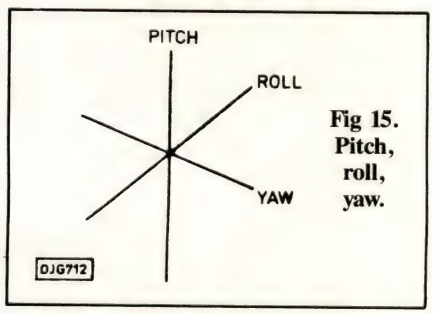


Fig 15. Pitch, roll, yaw.

Electric motors act on the momentum wheel to control the pitch. Gas jets are fired to control roll and yaw. For this purpose 12kg of hydrazine will last seven years. Every couple of months a little hydrazine is broken down into nitrogen, ammonia and hydrogen by passing it through a catalyst. This three-axis stability results in a craft pointing accuracy of ±0.1 degrees.

The 27 transponders on Intelsat V require about 800W of power. This is provided by two nickel cadmium batteries. Each battery is made up of 28 nickel cadmium cells capable of supplying 34 ampere-hours each when fully charged. When new, the solar cells can supply 1.54 kW of power but towards the end of their lives they can supply only 1.16kW which is still sufficient to power the transponders. PE

Next month Mike Sanders looks at Intelsat VI, aerials, and the future of satellites. And don't forget – the winner of the PE satellite TV system will be announced.

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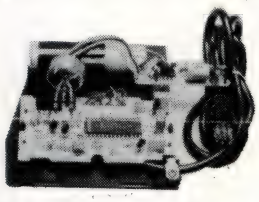

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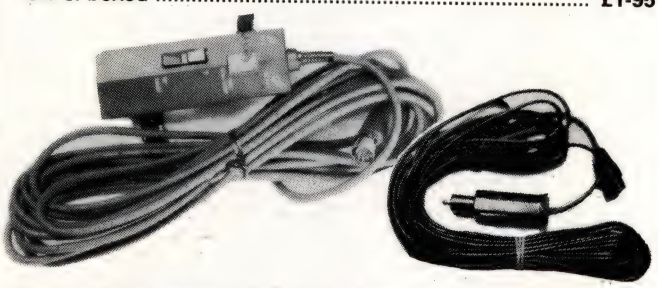

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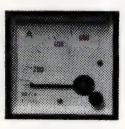

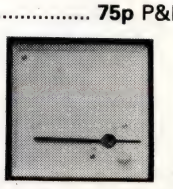

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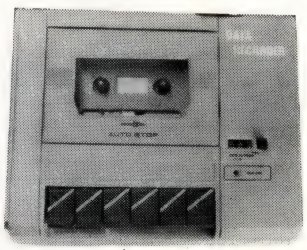

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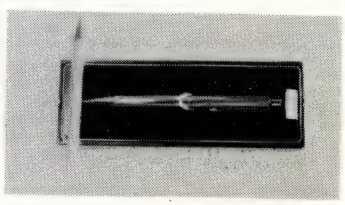

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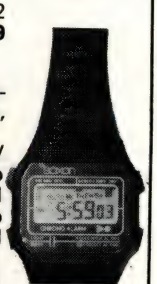

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PART TWO BY JOHN BECKER

SOLVING THE MISTRAL

In part 2 of PE's multiple meteorological metering, all our efforts are in vane, as we get the wind in our sails and convert breezes into binary.

In last month's article six simple circuits were described for monitoring temperature, light levels, rain, soil moisture and wind speed and direction. All are capable of being monitored by a voltmeter via a switch and individual connecting leads.

In part two this month an automatic control circuit will be described that will multiplex the control and reduce the connecting lead count to just three wires.

AUTOMATIC CONTROL

So far we have described the six detectors, and shown that they can be monitored directly by a manually operated switch. I shall now describe the circuitry that will put the monitoring under full automatic control. At the same time the number of connection leads can be cut down from eight to just three. Two of these are the power lines, and one is the data line common to all detectors. A block diagram is shown in Fig.16.

MULTIPLEXING

In order to monitor six remote circuits along a single data line, some form of coding is needed to determine which circuit is being monitored at any particular moment. There are several options from which one could choose. In these days of digital control for practically everything, binary coded data processing techniques are probably the most obvious method. However, I decided instead to explore and exploit a simiple frequency controlled analogue multiplexing method in conjunction with a clocked gate circuit.

Basically, this involves sending a frequency modulated pulse from the control unit down the line to a demodulator. This extracts the pulse which then steps a counter on by one place. Each counter condition is regarded as the address of a particular analogue gate connected to the detector to be monitored. When the gate is open the detector output voltage level passes through the gate, back along the line to the controller, where it can be monitored. Monitoring can be made directly by a voltmeter, or alternatively sent to a computer via an analogue to digital converter.

Inevitably, the circuit has to be a little more complex than this as several other factors have to be allowed for. The principal one is that of synchronising the signals in some way so that we know which detector is being monitored. The second is to ensure that the frequency pulses are not processed and displayed as monitor levels.

PULSE MODULATION

At the control end we first need two oscillators. One generates a high frequency carrier signal, and the other is a low frequency clock that switches the hf on and off the line.

In Fig.17, both oscillators are derived from similar circuits in which the different frequencies are set by the component values selected. The hf oscillator is formed around IC8d and IC8e. The frequency is determined by C13 and the total resistance of R57 and VR7. The latter presets the carrier frequency to match the needs of a demodulator at the detector end.

The clock generator is formed around IC8a and IC8b, with its time constant set by R53 and C12, running at one pulse every two or three seconds. The output is buffered by IC8c, which also serves as a gate that can be manually switched off by S1 to hold the multiplexed gate open to a particular detector for closer examination.

The clock is fed to the decade counter IC9, six outputs of which are coupled to leds. These visually indicate which state the count is at, and thus which detector is being monitored. We shall presently see how synchronisation is achieved.

The clock is also fed via S2 to IC8f which gates the hf frequency on and off, a high clock output inhibiting it. The pulsed hf signal is smoothed slightly by R59 and C14, and then, via R60 and C15, goes out along the data line to the detector unit. There it is passed to a filter consisting of IC1c and its associated components. This filter is set to only respond to the hf clock frequency, from which it extracts the clock pulse. The

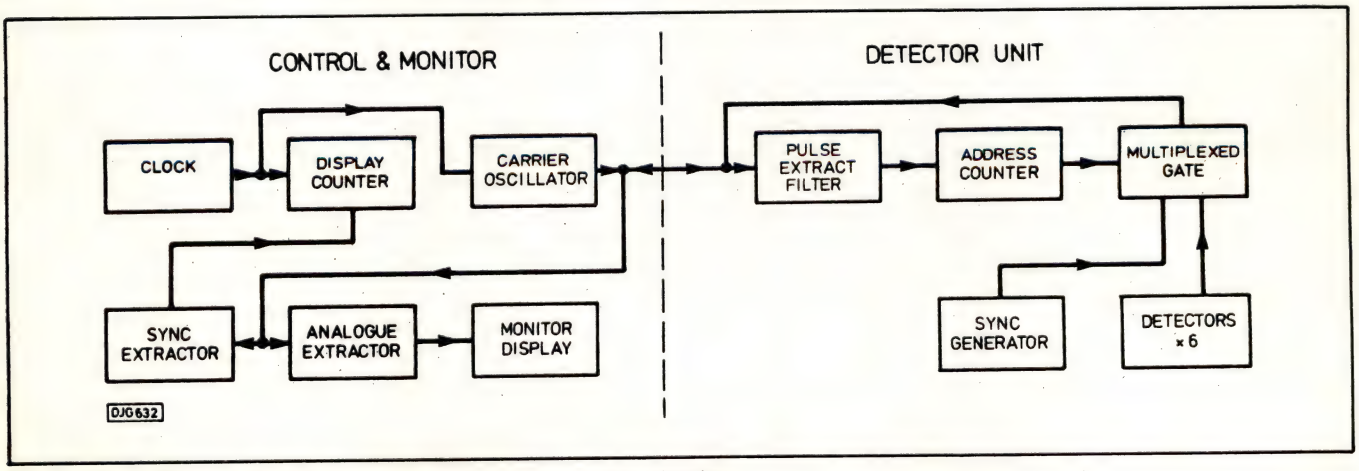

Fig 16. *Block diagram for the detectors, control and monitor circuits*

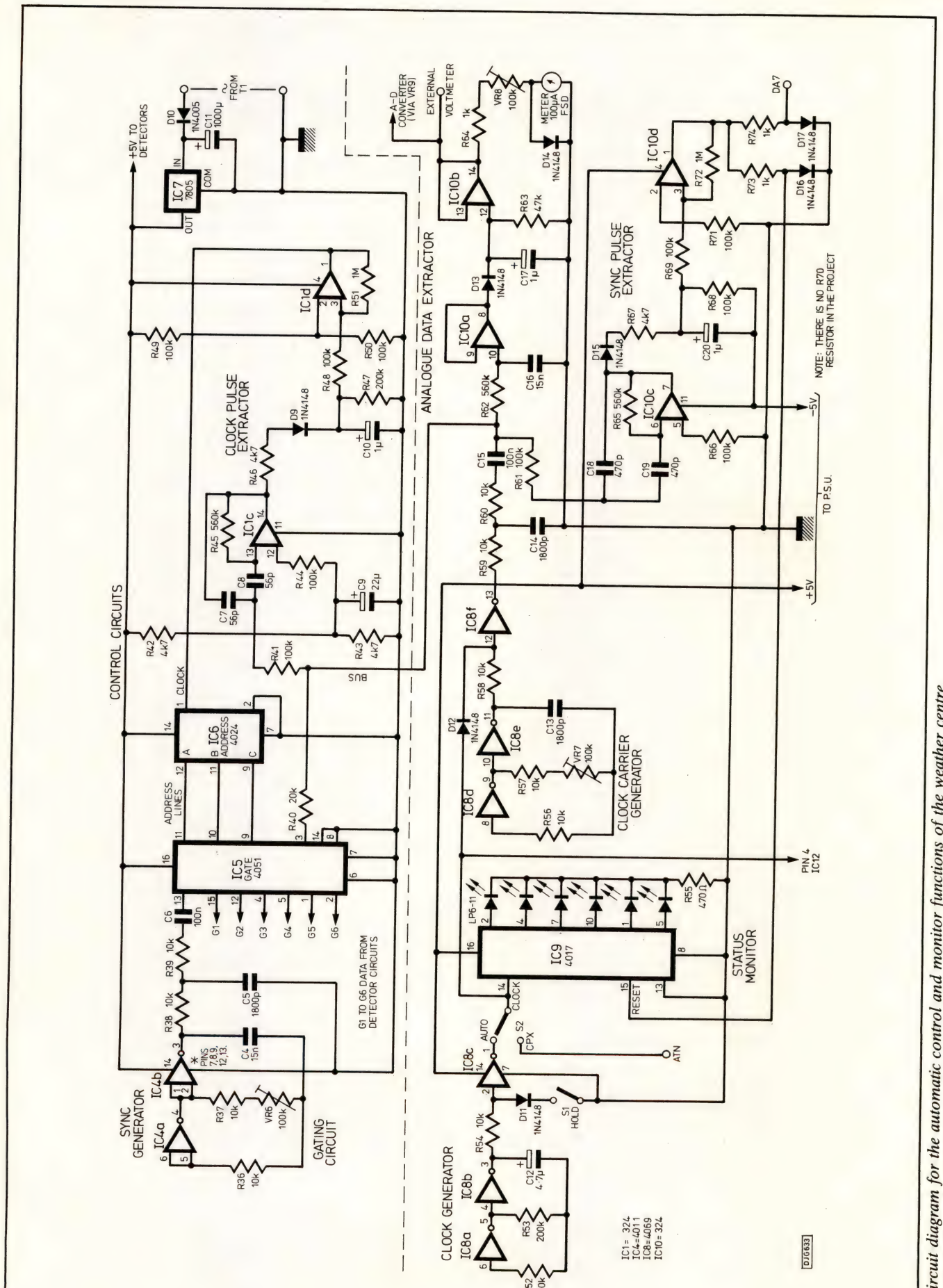

Fig 17. *Circuit diagram for the automatic control and monitor functions of the weather centre.*

band pass range is predetermined by the values of C7 and C8, but the optimum response is controllable by varying the carrier frequency by means of VR7.

The filter output passes via D9 to C10 and the comparator IC1d. Between them D9 and C10 provide an envelope duration control to minimise the risk of the following stage being triggered by short duration interference from other circuit operations. As the charge on C10 rises above the comparator threshold level set by R49 and R50, the comparator trips and its high going output sends a clock pulse to the address counter IC6.

MULTIPLEXED GATE

IC6 is a binary ripple counter the first three outputs of which provide the code that controls the multiplexed gate IC5. This has eight inputs and one output. Each input can be switched individually through to the output in response to a particular binary address code. One input is not used and so is grounded. Six of the others are connected respectively to the outputs of the detector circuits, G1 to G6. The address counter thus selects which detector is to be put on line.

Since IC5 is an analogue gate, the voltage level from the selected detector passes through the gate output to the data line via R40. This resistor prevents IC5 from being adversely affected by the clocked hf pulse. Although R40 is connected to IC1c, the filter will not be affected by the detector voltage levels.

ANALOGUE EXTRACTOR

Once the clocked hf pulse has ceased, the detected dc level passes back along the data line to the analogue data extractor around IC10a and IC10b. The extractor has been oblivious to the hf pulse due to the simple hf filter consisting of R62 and C16. The dc data voltage though, goes through the buffer IC10a, to charge up C17 via D13. The latter two also help to filter out any residual hf signal interference; IC10b buffers the stored dc voltage and makes it available for monitoring by a meter or an analogue to digital converter.

The meter may be any external dc voltmeter, or the meter shown. This is a 100μA meter, the current through which is set by R64 and VR8, the latter adjusting the current for full scale meter deflection when IC10b has its highest output level. D14 simply protects the meter against incorrect setting of VR8.

SYNCHRONISATION

So that we know which detector is being monitored, synchronisation of the status counter IC9 and the address counter IC6 is required. Another hf oscillator is the source for this sync signal, and its output is gated onto the data line every eighth clock pulse.

The oscillator is formed around IC4a and IC4b, with a frequency set by C4 and tunable by VR6. The output frequency is outside the pass band of the filter IC1c, and so is ignored by it. Similarly, the filtering around IC10a and IC10b eliminates it from the analogue data monitor circuits.

Instead, it passes to a sync pulse extractor filter around IC10c and IC10d. Needless to say perhaps, this filter is tuned to ignore the hf clock pulses. Its pass band is set to allow the sync pulse frequency through D15 to charge up C20, and on to the comparator IC10d. Once the sync pulse has been recognised, IC10d triggers upwards, sending a reset pulse to the status counter IC9 via R73. The pulse is also available for sending back to a monitoring computer via R74. Since the psu on this part of the circuitry has both positive and negative lines, the negative going content of the pulse is removed by D16 and D17.

As IC9 is automatically reset on each cycle, the leds LP6 to LP11 indicate which detector is currently being monitored and displayed on the meter. The sampling rate is slow enough for easy observation of the levels and the leds. S1 allows the cycle to be halted for closer examination of a particular function detector output.

POWER SUPPLY

Although the detector circuits can quite readily be run from a battery, it is more convenient to have the whole system operated from a mains power supply. There are three requirements here; a split level of ±5V to power the monitor circuits, and at least +5V for the detectors. The latter could run from a higher psu level, but circuit control is made easier by keeping the detector and monitor positive supplies at similar levels.

The length of the cable going from the control unit to the detector unit out in the garden somewhere requires that stabilisation of the detector supply should be at the detector end. Fairly high currents are drawn by the detector, largely because of the consumption by the leds. A long length of cable will of course introduce a significant resistance factor into it. With the currents drawn this resistance could cause fluctuations in the supply level at the end of the cable. Consequently, the detector has been given its own rectification and stabilisation circuit.

In Fig.18, transformer T1 is common to both detector and monitor units. The second and third wires of the three core cable going out to the garden carry the ground line, and the raw 9V ac from T1. In Fig.17, D10 and C11 rectify and smooth the power, then IC7 regulates it down to +5V. Back at the control end, +5V is produced via IC11 and the associated components, and −5V is rectified and regulated by D19 and D20. Basically only IC10 needs the −5V level, and as it draws very little current, full stabilisation by a separate regulator is not necessary.

PRINTED CIRCUIT BOARDS

There are two pcb designs, Figs. 19 and 20, which as well as containing the main detector and control circuits respectively, have additional sections on them that are removed and used separately. On the detector pcb in Fig.19, the rain probe tracking should be removed, and this will be mounted outside the box. The control pcb in Fig.20 in part three additionally holds the little sub-assembly boards for status, wind speed and direction leds. These too should be removed, and trimmed accordingly.

If the detectors are to be used with a manually switched meter, IC4 to IC7 and their associated components should be omitted, as should the components associated with IC1c and IC1d. Connections to the meter switch are then made at points G1 to G6 marked on the pcb layout diagram, omitting the link wires shown at those points. The battery con-

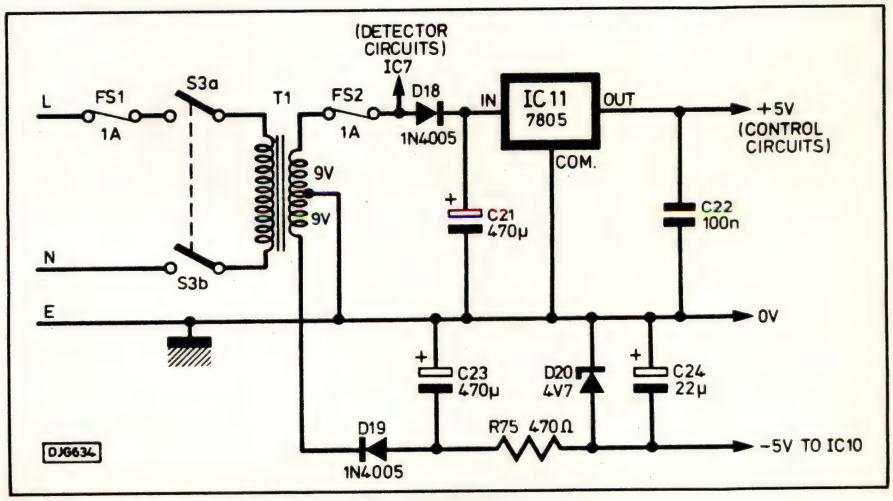

Fig 18. *Mains driven power supply*

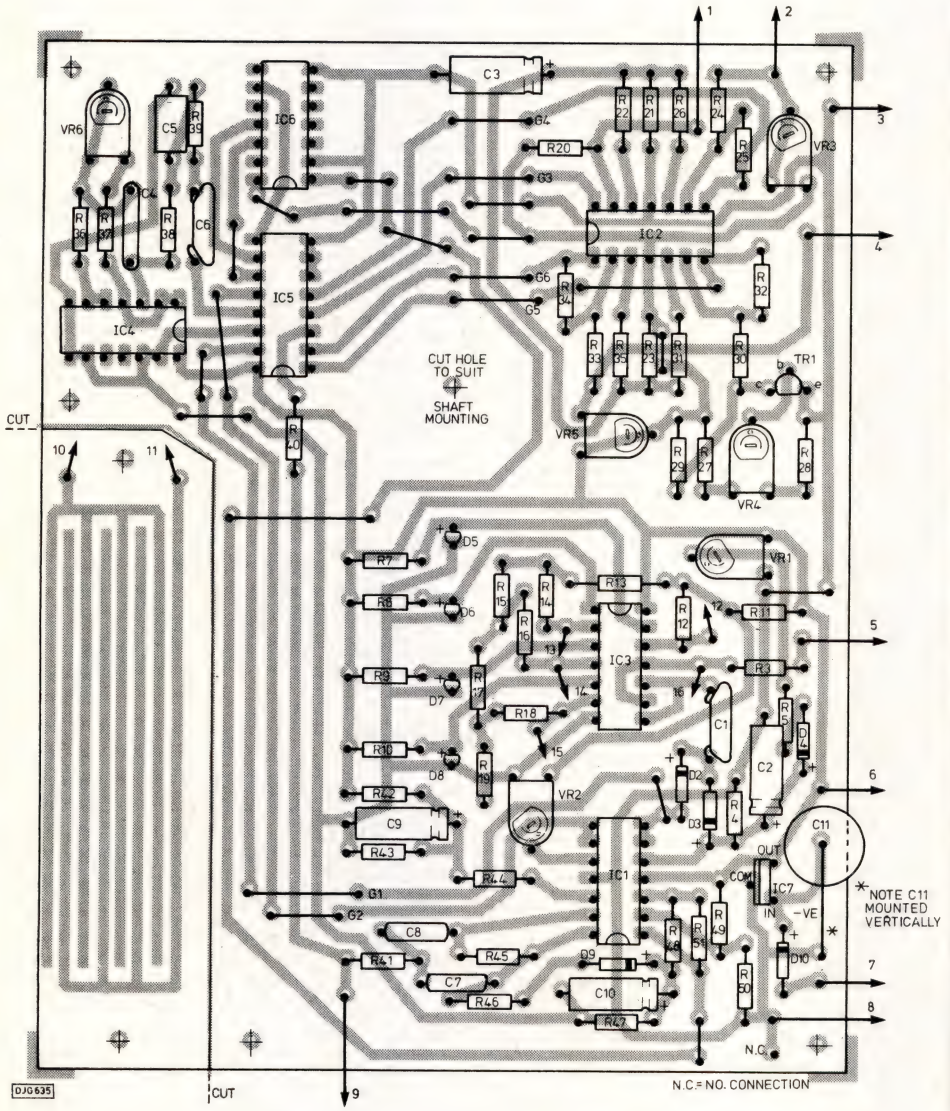

Fig 19. *Detector printed circuit board*

WEATHER — DETECTORS

RESISTORS

R1,R29	1k (2 off)
R2,R3,R5, R7–R11,R22, R24–R26, R30–R35	100k (18 off)
R4,R13,R15,R17, R20,R28	10k (6 off)
R6	270
R12,R14,R16, R18,R19	10k (5 off)
R21,R23	4k7 (2 off)
R27	47k

All resistors ¼W 5% carbon film

CAPACITORS

C1	100n polyester
C2,C3	22μ 16V electrolytic (2 off)

POTENTIOMETERS

VR1,VR2	100k skeleton (2 off)
VR3	25k skeleton
VR4	10k skeleton
VR5	500 skeleton

SEMICONDUCTORS

D1,D5–D8	IR-detectors (5 off)
D2–D4	1N4148 (3 off)
TR1	BC549
IC1,IC2	324 (2 off)
IC3	4069
LDR1	ORP12
LP1–LP5	Red led

MISCELLANEOUS

14-pin ic socket (3 off), pcb 275A.

CONSTRUCTOR'S NOTE

Kits of electronic components and the printed circuit boards are available from Phonosonics (see advert).

nections are made with +V at arrow 6 and 0V (battery negative) at arrow 8. The three sub-assembly sections on the control board will need to be made separately, either as shown, or on Veroboard.

The control pcb in Fig.20 also has IC12 and associated components on it. This is the D-A converter needed for the optional computer control to be described next month. It may be omitted if you do not intend to use a computer.

COMPUTER CONTROL

So far we have progressed from simple direct meter monitoring of the detectors in part one, through to remote monitoring via automatic control circuitry in part two. We can now look at how simply the unit can be put under computer control.

Although the example I shall give was destined for control by the Commodore Pet computer, the circuitry is suitable for use with any computer having an 8-bit control port, such as a Centronics, IEEE488 or User port. The progam listing is directly usable with the Pet, and additional information is given for modifying it for use with the Commodore C64 or the BBC-B. While neither PE nor I can offer information on converting the program for use with other machines, it should not be difficult to make the necessary changes in conjunction with your own machine's handbook. Principally, it is the address codes for the port control that will need changing.

All that the computer needs to do is to send out a trigger pulse on one of its port lines, read back a binary number from the analogue to digital converter about to be described, and then display the data on the screen. The display can simply take the form of decimal numbers, relating to the detected voltages monitored. It could also be made more sophisticated in a fashion similar to my own display. A third option is also open to exploitation — that of writing in correction factors to compensate for non-linearity in the detectors. Performing such corrections in software is much cheaper than using precision designed circuits; a point that Robert Penfold makes in his Real World Interfacing articles in February and March this year.

First, we switch out the clock generator IC8a-c, in Fig.17 last month, and connect IC9 and the hf gate to one computer line. S2 does this, and I chose to use the ATN line of the computer to send the trigger pulse at regular intervals. The multiplexed control for the detectors does not care where the control signal originates, so the trigger and data return routines still continue as before.

FRONTAL SYSTEM

Part three next month will continue the computer control description and illustrate how the detector and control units are housed. Derek, our artist has also done some nice drawings of the final mechanical details, and the gantry on which the detectors are mounted. Till then, keep warm and dry. PE

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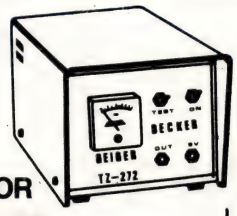

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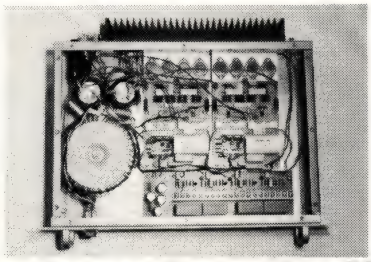

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4006	36p	4089	80p	74LS47	56p	74LS247	50p	6821	140p	75162	700p	7905	35p
4007	13p	4093	18p	74LS48	56p	74LS248	50p	6840	310p	75172	720p	7912	40p
4008	38p	4094	48p	74LS51	18p	74LS249	92p	6845	620p	75182	100p	7915	40p
4009	20p	4095	58p	74LS54	18p	74LS251	30p	6850	110p	75183	100p	7918	40p
4010	21p	4098	50p	74LS55	17p	74LS253	35p	8080A	400p	75188	80p	7924	40p
4011	13p	4099	45p	74LS73	28p	74LS256	80p	8085A	300p	75189	80p	78L05	28p
4012	13p	4501	30p	74LS74	22p	74LS257	42p	8155	380p	75195	185p	78L12	28p
4013	19p	4502	38p	74LS75	28p	74LS258	42p	8156	360p	75322	130p	78L15	28p
4014	35p	4503	32p	74LS76	28p	74LS259	58p	81LS95	120p	75324	340p	78L18	28p
4015	34p	4504	55p	74LS78	28p	74LS260	48p	81LS96	130p	75325	155p	78L24	28p
4016	18p	4505	200p	74LS83	43p	74LS266	28p	81LS97	130p	75365	145p	79L05	40p
4017	31p	4506	60p	74LS85	45p	74LS273	52p	81LS98	130p	75450	45p	79L12	45p
4018	33p	4507	33p	74LS86	30p	74LS279	40p	8224	270p	75451	42p	79L15	48p
4019	28p	4508	70p	74LS90	32p	74LS280	140p	8226	270p	75452	42p	7818KC	100p
4020	35p	4510	37p	74LS91	75p	74LS283	60p	8228	270p	75453	65p	7824KC	100p
4021	38p	4511	40p	74LS92	38p	74LS290	30p	8243	250p	75454	65p	LM309K	100p
4022	36p	4512	42p	74LS93	30p	74LS293	30p	8250	850p	75480	135p	LM317K	220p
4023	13p	4513	80p	74LS95	47p	74LS365	37p	8087	1100p	75491	60p	LM317T	180p
4024	25p	4514	75p	74LS96	60p	74LS366	37p	8251	300p	75492	60p	LM323K	420p
4025	13p	4515	75p	74LS107	32p	74LS367	35p	8253	320p	8T26	95p	LM723	40p
4026	60p	4516	40p	74LS109	34p	74LS368	38p	8255	310p	8T28	110p	78HGKC	570p
4027	18p	4517	120p	74LS112	38p	74LS373	55p	8256	1200p	8T31	330p	78HO5KC	800p
4028	29p	4518	38p	74LS113	32p	74LS374	55p	8257	350p	8T95	90p	78H12KC	700p
4029	35p	4519	39p	74LS114	35p	74LS375	58p	8259	360p	8T96	110p	78GUIC	190p
4030	17p	4520	38p	74LS122	400p	84LS390	50p	8271	3400p	8T97	90p	79GUIC	215p
4031	90p	4521	90p	74LS123	42p	74LS393	45p	8272	1200p	8T98	110p	79HGKC	800p
4032	54p	4522	50p	74LS124	85p	74LS399	80p	8279	450p				
4033	60p	4526	40p	74LS125	38p	74LS629	105p	8282	300p	**VOLTAGE REGULATORS**			
4034	80p	4527	44p	74LS126	38p	74LS641	110p	8283	400p	7805	35p		
4035	45p	4528	40p	74LS132	40p	74LS642	200p	8284	440p	7812	35p		
4036	180p	4529	75p	74LS133	34p	74LS644	280p	8287	360p				
4037	75p	4532	52p	74LS136	35p	74LS645	170p	8288	650p				
4038	48p	4551	80p	74LS138	35p	74LS670	72p	8748	1100p	**ZENERS**			
4039	190p	4553	190p	74LS139	35p	74LS674	400p	8755	1400p	**400MV**			
4040	38p	4555	29p	74LS145	83p	74LS687	270p	AY3-1015	290p	BZY88 RANGE			
4041	38p	4556	38p	74LS147	120p			AY5-3600	570p	2v7 to 39V	8p		
4042	30p	4557	190p	74LS148	90p	**COMPUTER ICS**		SPO256AL2	500p	**1.3W**			
4043	36p	4583	60p	74LS151	32p			Z80ACPU	180p	BZX61 RANGE			
4044	38p	4584	30p	74LS153	40p	2114	200P	Z80BCPU	500p	2v7 to 39V	12p		
4045	72p	4585	42p	74LS154	90p	2532	330P	Z80ADMA	650p				
4046	65p	**74LS SERIES**		74LS155	41p	2716	200P	Z80APIO	230p	**LED**			
4047	45p	74LS00	15p	74LS156	47p	2732	280P	Z80BPIO	480p	LED 3mm RED	5p		
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4049	18p	74LS02	15p	74LS158	33p	2764	240p	Z80BCTC	480p	LED 3mm GRN	10p		
4050	20p	74LS03	15p	74LS160	48p	27C64	550p	Z80ASIO	680p				
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4052	37p	74LS05	15p	74LS162	48p	27256-25	400p	Z80ASIO-2	700p	LED 5mm YEL	10p		
4053	37p	74LS08	15p	74LS163	46p	41256-15	300p	Z80ADART	680p	LED 5mm GRN	10p		
4054	53p	74LS09	15p	74LS164	43p	256DRAM	300p	74S188	175p				
4055	52p	74LS10	15p	74LS165	65p	4116	75p	74S189	210p				
4056	52p	74LS11	15p	74LS168	74p	4164	110p	74S201	240p				
4060	40p	74LS12	15p	74LS169	92p	6116	160p	74S287	190p				
4063	52p	74LS13	22p	74LS170	85p	6264-15	250p	74S288	180p				
4066	20p	74LS14	30p	74LS174	80p	6502	300p	74S289	180p				
4067	130p	74LS15	15p	74LS175	39p	6502A	400p	74S387	200p				
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4069	13p	74LS21	15p	74LS191	55p	6503	570p	75108	80p				
4070	13p	74LS22	15p	74LS192	52p	6520	170p	75109	110p				
4071	13p	74LS24	38p	74LS193	50p	6522	330p	75110	80p				
4072	13p	74LS26	15p	74LS194	51p	6530	1050p	75112	140p				
4073	13p	74LS27	15p	74LS195	53p	6532	400p	75113	105p				
4075	13p	74LS28	15p	74LS196	52p	6545	880p	75114	130p				
4076	45p	74LS30	15p	74LS197	82p	6551	530p	75115	130p				
4077	13p	74LS32	17p	74LS221	52p	6800	210p	75121	125p				
4078	13p	74LS33	17p	74LS240	58p	6802	220p	75122	125p				
4081	13p	74LS37	16p	74LS241	55p	6803	800p	75150	110p				
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A selection of novel ideas
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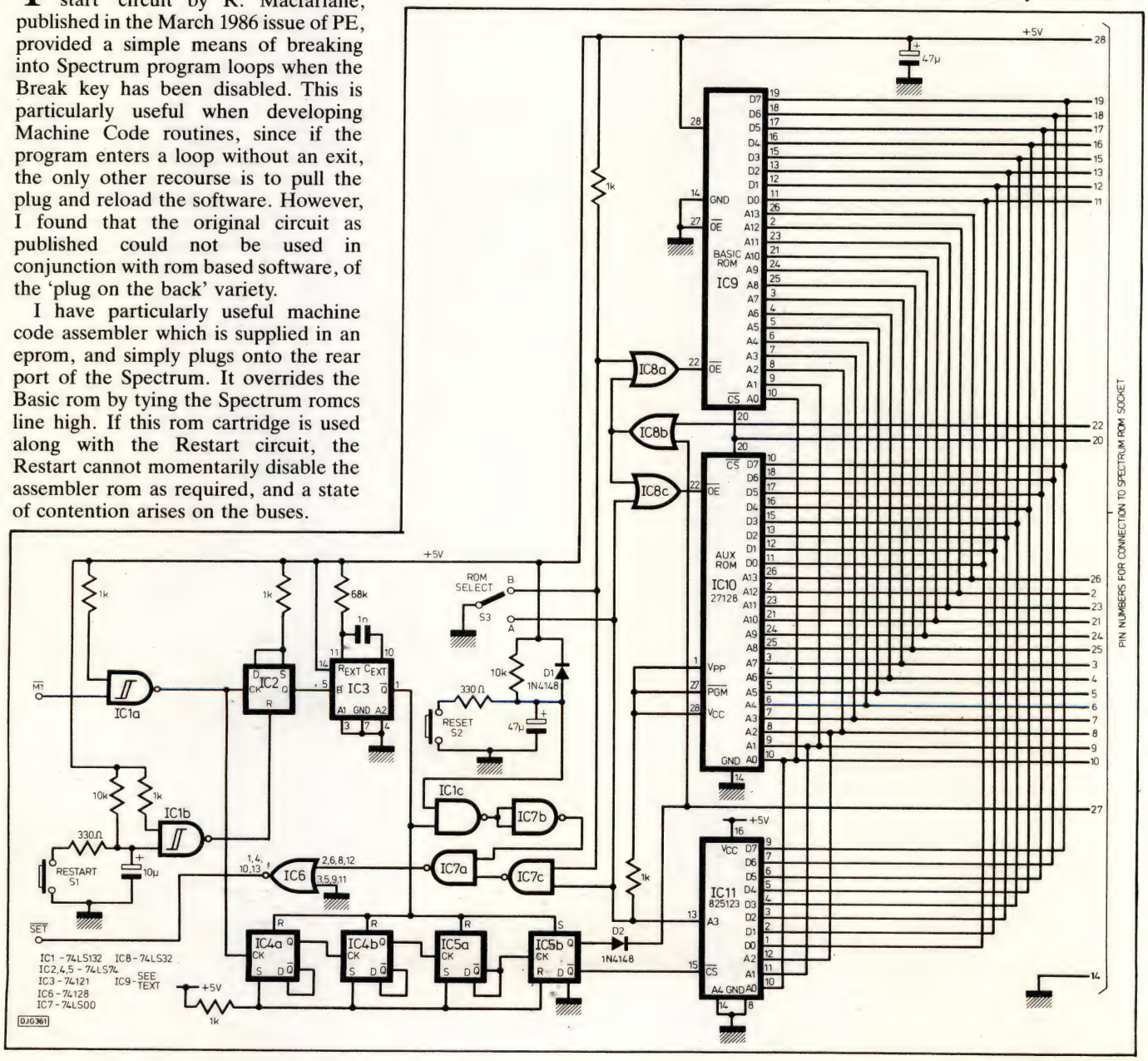
Spectrum Hardware Restart/ ROM Select

THE original Spectrum 'Hardware Restart' circuit by R. Macfarlane, published in the March 1986 issue of PE, provided a simple means of breaking into Spectrum program loops when the Break key has been disabled. This is particularly useful when developing Machine Code routines, since if the program enters a loop without an exit, the only other recourse is to pull the plug and reload the software. However, I found that the original circuit as published could not be used in conjunction with rom based software, of the 'plug on the back' variety.

I have particularly useful machine code assembler which is supplied in an eprom, and simply plugs onto the rear port of the Spectrum. It overrides the Basic rom by tying the Spectrum romcs line high. If this rom cartridge is used along with the Restart circuit, the Restart cannot momentarily disable the assembler rom as required, and a state of contention arises on the buses.

This modified version of the original design overcomes this problem, and offers other advantages. This circuit takes the Basic rom and any other auxiliary roms such as an assembler, and incorporates them into the Restart circuit, whilst providing a panel mounted switch to select the operating system required. Looking at the circuit diagram, and comparing it to the original, the Restart timing part is essentially unchanged – a few gate alterations were made to incorporate the new features, and to reduce the package count. The main new feature is the inclusion of IC9 and IC10 on the board. IC9 is the Basic rom itself, as supplied with every Sinclair Spectrum. In most machines, this appears to be in a socket anyway, but if soldered in, a little desolder wick will ease removal without damaging the delicate pcb tracks (*though it will probably negate any guarantee. Ed*).

IC10 is a 16k byte rom containing the alternative software, the assembler for instance, taken from the plug-on module. IC11 is the original Restart prom, as described in the article. The idea is that all the circuitry shown is on



a new circuit board mounted above the main Spectrum board using pillars. Obviously, this will not fit into the original Sinclair casing, but then most serious Spectrum users seem to have rehoused their machines in larger 'real keyboard' cases anyway! The numbered connections to the right of the circuit correspond to the pin numbers of the Basic rom socket in the Spectrum itself. If a ribbon cable, terminated in a 28 pin dil header plugged into the Spectrum rom socket, is used to form these interconnections, only two other wires need to be used to complete wiring up, these being M1 and reset, made directly to the Spectrum's Z80 or alternatively to the edge connector. Of course a rear mounting edge connector arrangement could be used for all of the bus connections, as in the original article, but using the dil header proves to be very neat and reliable.

Switch S3 acts as a selector for the rom software. To select a rom, its appropriate output enable pin, pin 22, must be driven active low. This occurs when the Spectrum makes pin 22 (RD strobe) and pin 27 (romcs) of its rom socket both active low, checked via IC8b, and when S3 transfers this signal via IC8a or IC8c to one of the roms, whilst disabling the other. Address line A3 of the Restart prom is derived also from S3, and this allows the Restart addresses in IC11 to be individually selected for each rom, similar to switch bank S3 in the original design

Extra logic, in the form of IC7, provides a further feature. If S3 is a break-before-make switch, the output of IC7c flicks low momentarily each time the switch is altered, since its inputs both go high during the transition. This, via IC7a and IC6, produces a system reset pulse, to ensure that when the selected rom is changed, the newly enabled software starts executing at its reset vector. Note also that D1 has been added to ensure the reliability of an automatic reset at power-up, even if the supply is only momentarily interrupted.

Finally, if desired, the circuit can be simply expanded to cater for as many extra roms as needed, by expanding S3 and providing more versions of IC8c, and adding more inputs to IC7c.

G. Durant, Cambridge.

Stereo grannyphone interface

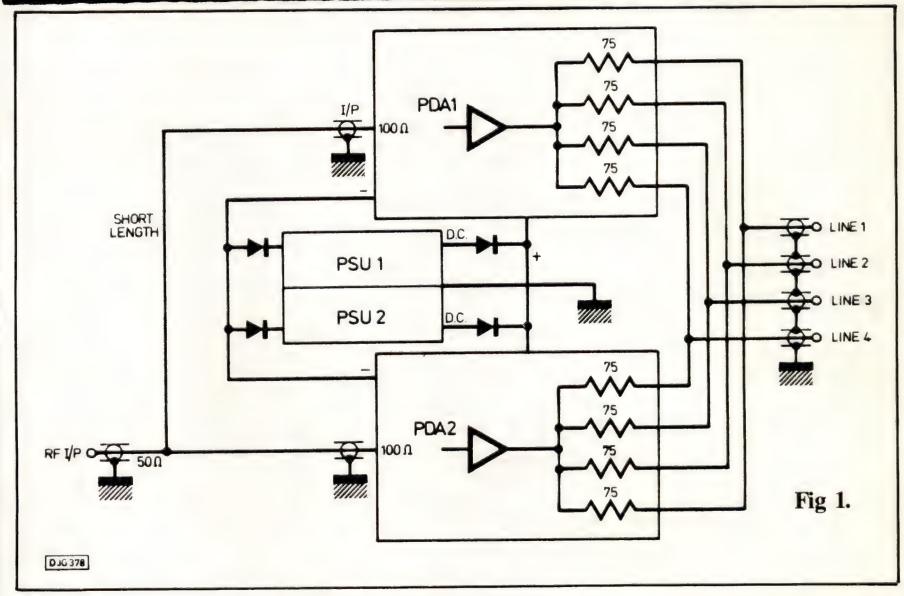


Fig 1.

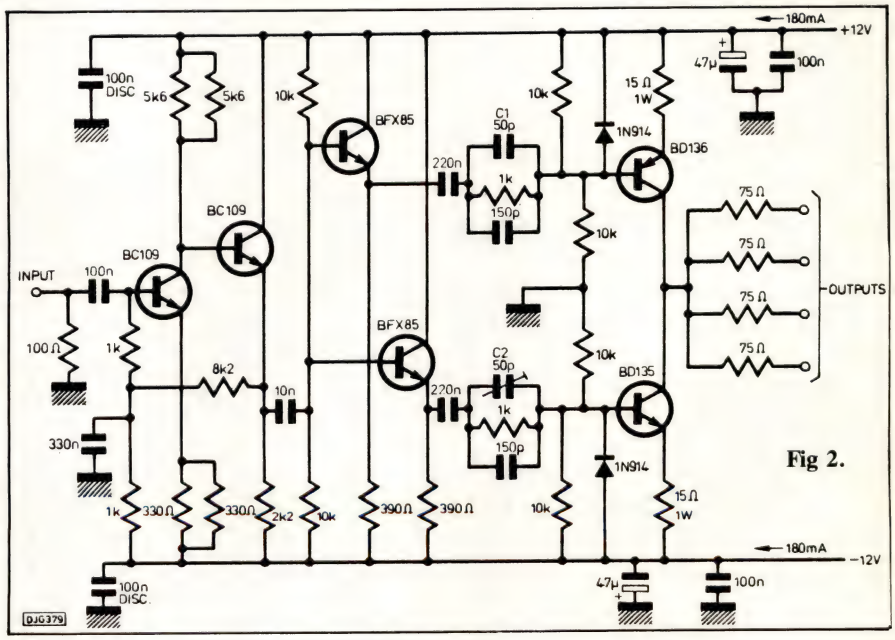


Fig 2.

High Reliability Pulse Feeder

THE author was recently asked to produce a distribution system which had to distribute four feeds of 2 MHz rf carrier over long 75Ω coaxial lines. The signals were 8V P-P with fast rise and fall edges of 50ns. A feature of the system was that it had to be highly reliable.

It was decided that the distribution amps would operate in parallel for increased reliability , and that two wired-OR power supplies should be used. Both these features would enable "no break" maintenance checks to be undertaken.

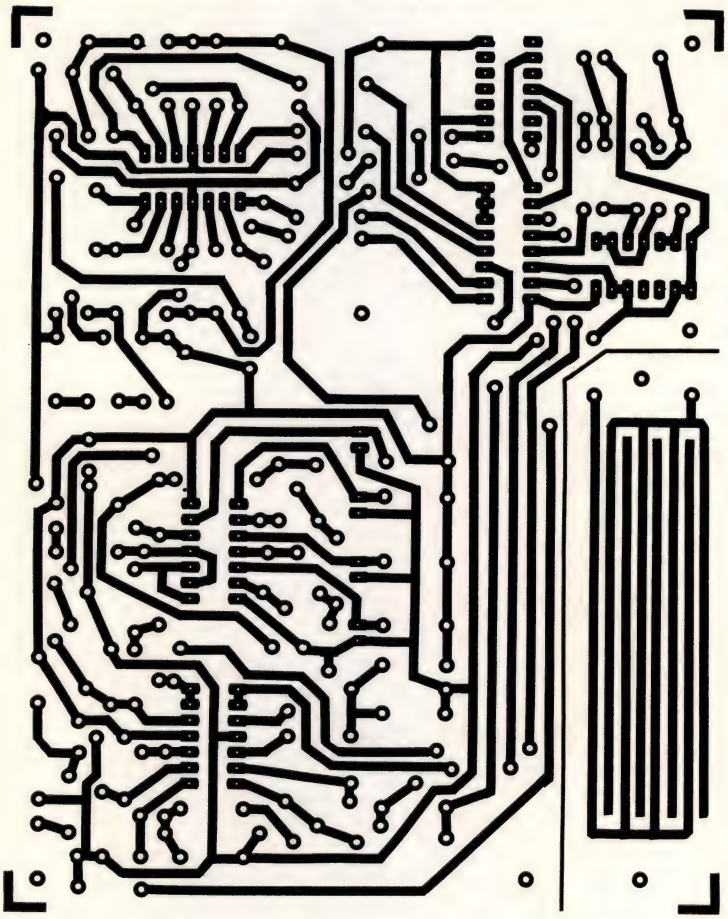
If one of the coax lines were to become faulty, i.e. short or open circuit, this situation must not affect the remaining feeds.

An output port to port isolation of 20 db was required and the amplifier had to be easy to construct and use only easily available devices.

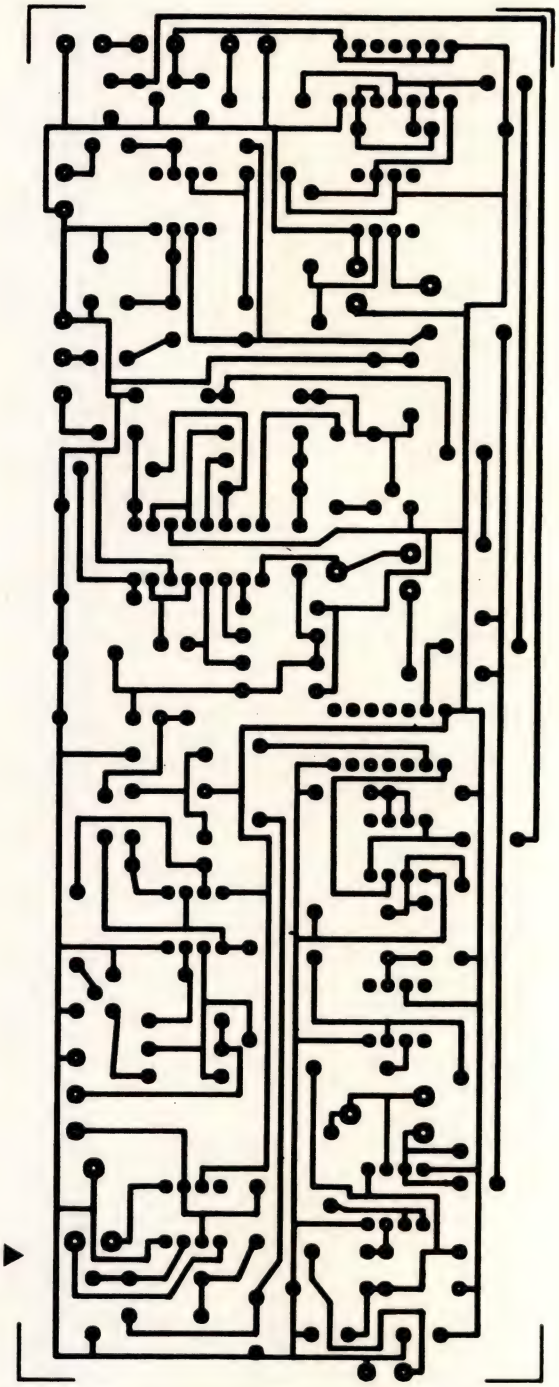
Fig 1 shows the general arrangement, and Fig 2 shows the circuit of the distribution amplifier.

A.B. Bradshaw, Sandy.

PCB TRACK PATTERNS



Weather Centre: detectors (less than life size: space between IC pins is 0.1 inches).



PE 169 ▶

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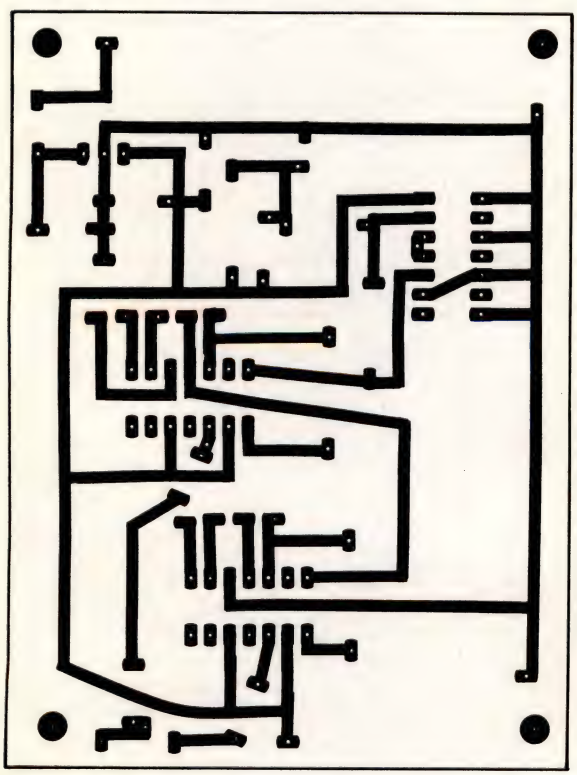
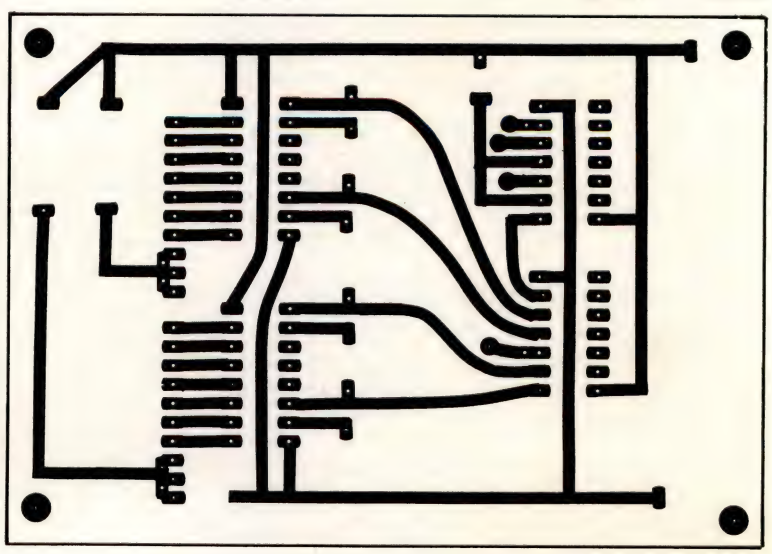
PE 171





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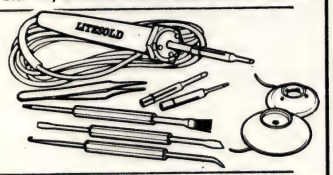

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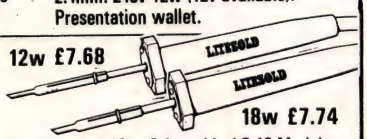

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LC18	£2.09	£1.20

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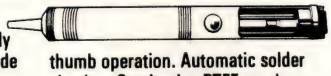

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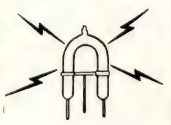
XK125 Complete kit of parts £24.00

POWER STROBE KIT



Designed to produce a high intensity light pulse at a variable frequency of 1 to 15Hz, this kit also includes circuitry to trigger the light from an external voltage source (eg. a loudspeaker) via an opto isolator.

Instructions are also supplied on modifying the unit for manual triggering, as a slave flash in photographic applications or as a warning beacon in security applications. The kit includes a high quality pcb, components, connectors, 5Ws strobe tube and full assembly instructions. Supply: 240V ac. Size: 75x50x45.

XK124 Stroboscope Kit **£13.75**

VERSATILE REMOTE CONTROL KIT

This kit includes all components (+ transformer) to make a sensitive IR receiver with 16 logic outputs (0-15V) which with suitable interface circuitry (relays, triacs, etc – details supplied) can be used to switch up to 16 items of equipment on or off remotely. The outputs may be latched (to the last received code) or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits.

Supply: 240V AC or 15–24V DC at 10mA.

Size (excluding transformer) 9 x 4 x 2 cms.

The companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available MK9 (4-way) and MK10 (16-way), depending on the number of outputs to be used.

MK12 IR Receiver (incl. transformer)	£16.30
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MK9 4-Way Keyboard	£2.20
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701 115 Additional relays **£1.80**

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BIO-CHROMATIC ELECTRONICS

BY ZOLA McMALCOLM

BIOLOGICALLY BASED OPTO ELECTRONICS BROADENS INTELLIGENT COMPUTING HORIZONS

The ability of some photo-sensitive plant substances to undergo a chemical colour change on exposure to high-intensity sunlight is providing clues which may lead eventually to genuinely organic, self-replicating data storage matrices.

SPEED, density and reliability are among the keywords paramount in laboratories researching into new and better ways of manufacturing semiconductors. With each new generation of silicon based device, the requirements of industry, commerce and the military, far from being satisfied, are tantalised by the prospect of taking technology yet another step forward.

Thus, since the introduction of the humble transistor, increasingly sophisticated semiconductors have been regularly appearing, including the recently introduced and revolutionary transputers.

Each generation of device has come into existence through the unstinting efforts of research scientists, pressure from prospective end users, and the incentives of reaping large financial rewards. Indeed the field of electronics is an exemplary illustration of the old saying that Necessity is the Mother of Invention.

Some of the inventions are more precisely logical extensions of existing technology. Others have required the use of new materials, expensively and painstakingly researched. Additionally the achievements of other technologies and diciplines have also had their impact upon the ability to manufacture faster and smaller semiconductors.

DISCIPLINARY INTEGRATION

One notable example of interdisciplinary application is the availability of higher definition photographic emulsions suitable for circuit imaging. As many photographers will be aware, the structure of photosensitive emulsions can lead to 'graininess', through clumping of the chemical compounds. The human eye usually ignores the coarse appearance of a photographic image, but in electronics grain size and image sharpness become significant when components and signal paths are printed photographically, and even graded grains may be too coarse.

Chemistry has played an important part in the increased sophistication of photographic emulsions and in the production of new semiconductor materials. Allied disciplines have enabled advances in crystalography and diffusion techniques to be applied to the growth of precision semiconductor structures. Through these techniques, complex integrated systems have become commonplace, with capabilities, speeds and reliabilities that were only dreamed of a few years ago.

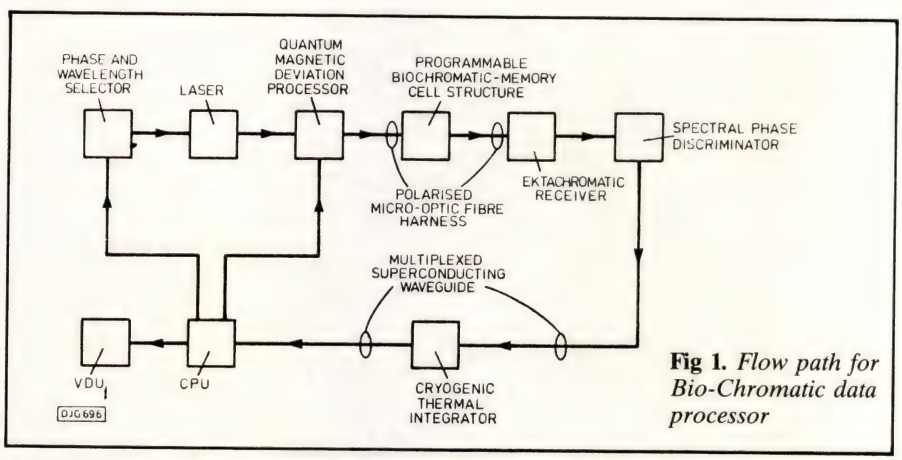


Fig 1. *Flow path for Bio-Chromatic data processor*

Much to the benefit of electronic miniaturisation, another technology has also been put to good use – lasers. About the same time that integrated circuits were being introduced, lasers were in the process of becoming fact rather than science fiction. Strangely, at the time they appeared to be a product without a purpose. I recall that either *New Scientist* or *Science Journal*, or probably both, speculated heavily about the functions to which these remarkable devices could be put. Now, over two decades on, we are probably complacent about their benefits to society at large, from use in medicine, entertainment, industry, defense, data storage, communications, as well as electronic component manufacture. In the latter application, the precision imaging techniques are capable of literally cutting components and signal paths into specially prepared mineral compounds of materials like silicon, germanium, gallium, arsenic and so on.

INFANT TECHNOLOGY

Although not widely publicised in the popular press, a new technology is now in the early stages of making its impact felt on the electronic manufacturing scene. It is very much in its infancy, and there is much yet to be researched and achieved. While premature speculation should be regarded with caution, the techniques being developed may lead to achieving truly intelligent computers by methods radically different from those being examined in other spheres.

Several well established disciplines have been brought together for the research project in which I am currently involved at an investigative science laboratory in Kent. While the laboratory's primary interest is in electron theory applications, the fields of solar reactive chemistry, regenerative microbiology, and epi-polycryptic communication systems are heavily featured on the research curriculum.

SOLAR REACTIVE CHEMISTRY

Solar reactive chemistry was probably first studied in depth during the early nineteenth century in experiments that ultimately led to the invention of photography. Although it was eventually found that silver-iodide was the substance that showed the best chromatic change in response to exposure to light, numerous other

substances, such as albumen and starch were also given close attention. Both substances were readily available in the form of eggs and potatoes. The latter's reaction to light will be well known to anyone who has forgotten to keep peeled potatoes covered. Many other biological examples are readily observable around us, including the reaction of foliage to light, resulting in pigmentation changes through production of substances like chlorophyl.

My own interest in photochemical reactions started after a lengthy sunbathing session when I painfully observed that even human tissue can be changed in hue by exposure to sunlight. It was also noted that areas are selectively affected, depending on the exposure duration and intensity.

Following this simple observation, and repeating the researches of the nineteenth century, I began examining the reaction of other substances, in particular the way that various plant structures behaved differently to light stimulii. Further research showed that different light wavelengths created different chromatic changes. Though many were permanent, some changes could be reversed by exposure to the inverse end of the colour spectrum. It was also of interest that, to a certain extent, the areas affected could be moderately well controlled by rudimentary focusing of the light source.

LASER CONTROL

With the advent of lasers, it was found that the precision focusing and opto-frequency control techniques were capable of initiating chromatic changes to individual cells, leaving surrounding cells unaffected. Using different biological sources as the experimental specimens, it was found that some were faster to react than others. One species of plant was particularly rapid in response, showing a reversible reaction time of only a few milliseconds. This was one of the hybrid varieties of the foxglove family, Digitalis-Multiflora.

Wild digitalis multiflora

It then became apparent that a biological substance had been synthesised that, in conjunction with the precision of laser technology, could be reversibly used as a programmable data store. The logic state would be determined by the colour of the cell, and could readily be assessed using miniature chromatic sensitive opto-detectors. Although photographic emulsions can store optically coded data, the process is basically non-reversible and incapable of reprogramming. Within this plant though, there appeared to be a highly reactive bio-chromatic substance that could be rapidly reprogrammed. It was however, subject to data loss as the plant decayed.

BREAKTHROUGH

A breakthrough came when discussing the problem with a colleague at the laboratory who was involved in micropropagation techniques for horticultural applications. I explained the reluctance of the samples to stay unwilted for more than a few days and asked if there was a method of preserving Digitalis, in the same way that some other flower species can be dried and preserved. He suggested that there might be, by crossing Digitalis-Multiflora with Surillious Preposterosa, a Moroccan desert plant well suited to longevity in arid conditions.

Cultivated surillious preposterosa

Specimens of this plant were acquired and crossed with Digitalis. Ultimately the seeds were collected and sown. The resulting hybrids were then analysed for their ability to respond to laser beam programming.

The results surpassed expectations, with not only the permanence of the recorded data being considerably extended before natural decay set in, but also a ten-fold increase in the recording response rate was experienced, subsequent chemical and spectral analysis of this hybrid showed arsenic hydroxide and minute traces of lithium Stearate coming from Digitalis, and silicon dioxide from Surillious. It appeared to be the combination of these that was responsible for the reaction rate.

FORTNIGHT AT F8

Over the next several months, eight successive 'F' generations of the hybrid were produced in accordance with accepted horticultural practice, selecting the best from each generation and using them as the parents for the next. To speed growth and stabilise a 100% arsenic-silicon alignment (ASA 100) within each generation, bi-diurnal

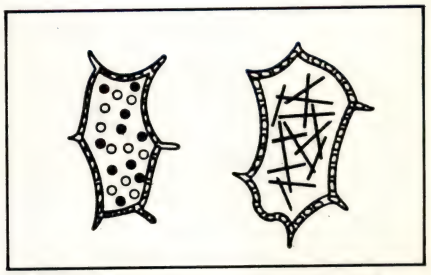


Fig 2. *Cellular chromoplasts. (Left) from Digitalis. (Right) from Surillious.*

microwave progagation techniques at the nano-angstrom level were rigidily enforced. The ASA 100 exposure factor was determined computationally and for each generation up to F8 it was found to be around a fortnight.

Using the F8 hybrid we took advantage of the rapidly developing technology of micro-biological propagation, in which selected plant cells are cloned. This involves the plant with the best chosen characteristics having cells removed from a growth nodule, and growing them in a precisely forumulated culture medium. Since the clones obtain their entire nutrient from this medium, it has to consist of a standard growth hormone plus the base elements found in the natural plant, in this case lithium (Li), arsenic (As), and silicon (Si). Earlier tests had shown that slight impurities of chrome and nickel (Cr and Ni) could enhance the colour monotonacity and durability of the opto-cellular response. Using an inert heavy duty polycellular hydro-carbonic (H_20-C_3) gel base, the nutrients and required proportions of each element were added, and the cells implanted. The culture plates were then put into a centrifuge rotating at 5G.

BINARY EXPANSION

Normally cloned poly-cells will grow according to the genetic codes inherent in the original plant. This usually results in the total replication of the original. However, using an artificial gravity of 5G, the cellular multiplication direction is inhibited. Consequently, the growth develops as a geometricically precise disc. Growth was permitted until the horizontal cell count was 2^{32}. Due to the 5G factor, the growth stopped vertically at the 128th cell. Somewhat to our surprise, it was then found that the

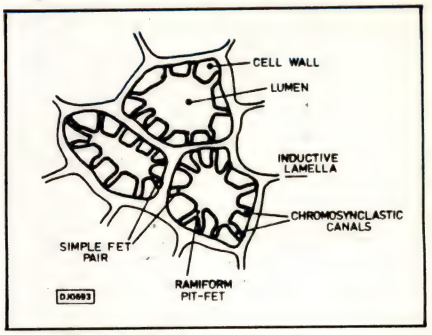


Fig 3. *Poly-cell fet junction*

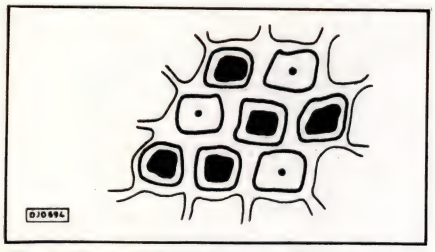


Fig 4. *Typical 8-bit binary chromoplast structure. Darkened areas are at Logic 1.*

dendrites of the outer cells were several microns thicker than the inner ones and all had a high proportion of nickel in them. However, this was an advantage since the rigidity of the growth was such that it was capable of being supported in a normal optical frame using polarised stress sensors to maintain uniformity.

DOUBLE DENSITY PLOTTING

Subjecting this bio-structure to pulsed laser beams, the expected reversible colour changes were found to occur as in the original experiments, though at a greatly enhanced reaction rate. It was noticed, though, that some cells did not respond as predicted; either they failed to react at all, or they had a density twice that of the majority. In case this was due to slight inaccuracies in the supporting frame and its sensors, the sample was repositioned, and the sensors checked and reset. A similar unevenness was experienced. After several attempts at repositioning and resetting, it became obvious that there was a correlation between the cells affected, and the polarity of the sensors.

It became obvious that the chromaticity of the opto-reaction was being affected by induced currents generated in the nickel based dentrites by the stress sensors, in a piezo-electric fashion. This was being modified further by the presence of the silicon compounds in the cell structure. The effect was that those cells of a neutral electrical polarity responded normally, those having a negative potential across them failed to respond, while those of positive potential responded by doubling their density change. In other words, the cellular structure had a tri-state mode of operation and possessed the characteristics of a sophisticated semiconductor.

BOOLEAN ANALYSIS

The logical next step was taken. Individual connections were made to a small group of cells so that a tri-dimensional matrix was produced. These were connected to three buffered 32-bit RS332 computer ports, and Boolean logic levels systematically applied in conjunction with synchronously clocked laser pulses. Cell density data was collected via ektachromatic transducers and the results conformed to the predicted truth tables.

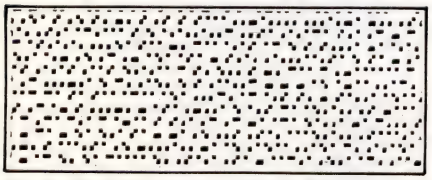


Fig 5. *Typical cross-section of programmed poly-layer structure.*

The implications were profound. We had produced a bio-electronic tri-state laser programmable data store. Digitalis Multiflora had been hybridised to become Digitalis Electronicus!

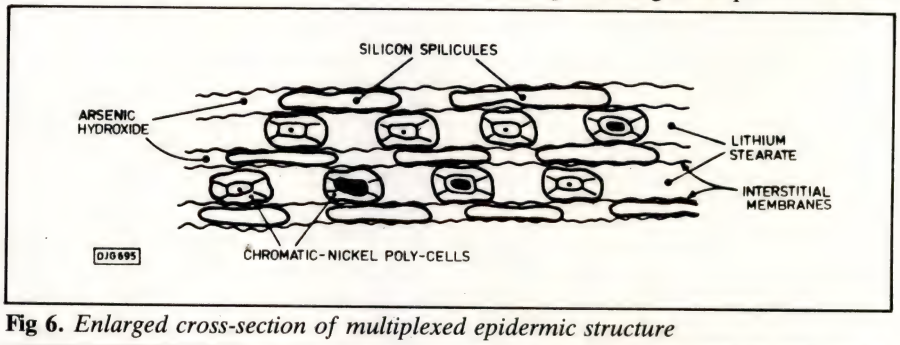


Fig 6. *Enlarged cross-section of multiplexed epidermic structure*

ULTRA HIGH SPEED

A further surprise was yet to be revealed. When checking the complete clone growths for data conversion time, it was found that an additional gating factor existed, and depended on the respective laser wavelength phases. This resulted in data transfer rates as fast as 0.5 femto-seconds. A major advance in the search for even faster data processing devices had thus additionally been achieved. The importance of high speed processing is that it is one of the vital parameters required for the ultimate production of intelligent computers. Consequently, it is believed that our researches and achievements represent a significant step towards man-made systems that will one day match, and probably surpass the abilities of the human brain.

The problem of eventual data decay has not yet been fully overcome, but the current generation of devices has extended refresh cycle times of around 17 weeks at 20°C and 33% humidity. since the data refresh routine only requires the addition of two drops of any standard hydroponic culture solution per device, and can readily be put under capillary irrigation control, this rate is insignificant under normal operating conditions. It should also be noted that, as with eprom devices, exposure to uv light has to be avoided. As part of the continuing research program we are also investigating the possibility of cloning fully pre-programmed devices for mass production in large scale culture trays.

COOPERATIVE SOCIETY

The effects of vegetative chromaticism have been observable for countless generations, and they are essential to universal ecological stability. We now have the opportunity to benefit further from exploitation of this natural phenomonon. However, as this research saga shows, it is only through the ready interchange of technological knowledge between disciplines, irrespective of their disparity, that material advances beneficial to society in general can be achieved. The success of our collaborative investigations is a classic example of the application of knowledge from two such disciplines. Electro-horticulture may well prove to be the most significant growth product of this century, profoundly enhancing the socio-economic benefits of applied technology. It has only come about though, through interdisciplinary co-operation.

While it is unwise to definitively predict the outcome of full commercial distribution of Digitalis Electronicus based devices, one possible side effect is that home computers may well eventually be retailed by garden centres as well as high street electrical stores. With further research and innovation it also may be practical for sophisticated systems to be grown in back gardens. Should such advances be made perhaps one day the Chelsea Flower show and the All Electronics Exhibition may become a combined event. Undoubtably relevant magazines would also undergo significant changes, possibly combining their resources, resulting in such titles as *Practical Gardening Electronics: the horti-science magazine for serious floral electronics and vegetative computing enthusiasts.*

For those wishing to grow Digitalis Electronicus, the clonal growth culture formula is $Cr_{39}\ 0_5\ H_7\ Ni_{17}\ C_5\ Si_1\ Li_4\ As_{88}$. **All enquiries should be made in writing to** Rekceb-Rotide Research Laboratories, 8 Finucane Drive, Orpington, Kent, BR5 4ED. PE

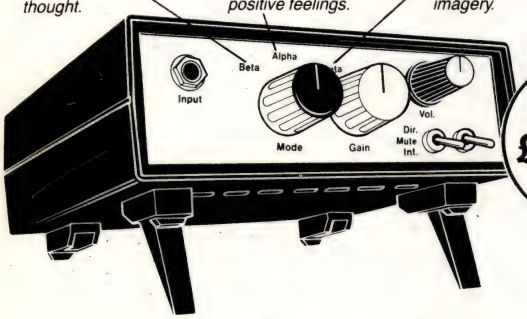
Zola McMalcolm with F5 generation hybrid digitalis multiflora

Brainwave monitor

β BETA – *Concentration, problem solving, active thought.*

α ALPHA – *Relaxation, pleasure, tranquility, positive feelings.*

θ THETA – *Imagination, creativity, hynagogic imagery.*



BRAINWAVE MONITOR PARTS SET ONLY £36.90 + VAT

This unique project will allow you to **hear** your own brainwaves! Through a simple training program you can learn to **control** them and achieve peak performance in all situations. It will revolutionise your life!

The approved parts set contains: two PCBs; all components, including three PMI precision amplifiers; shielded box for screening the bio-amplifier; attractive instrument case with tilting feet; controls, switches, knobs, plugs, sockets; leads and brass electrodes, full instructions for assembly and use.

Parts are available separately. We also have a range of accessories, professional electrodes, books, etc. Please send a stamped, self-addressed envelope if you just want the lists. Otherwise, an SAE + £2 will bring you lists, construction details and further information.

THE ALPHA PLAN

Can you really train your mind to think more effectively? Can you really excel at things you're 'no good at'?

The Alpha Plan has all the answers!

£2.50 (no VAT)

SILVER SOLUTION

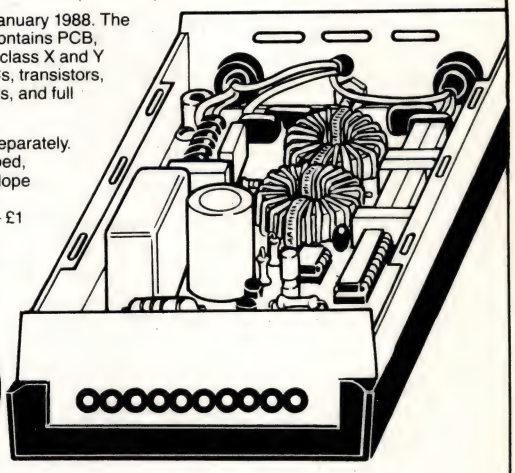
Just wipe on with a cloth to plate PCB tracks, connectors, wire, component leads, coins or hosehold ornaments with a layer of **pure silver**. It must be magic!

LARGE BOTTLE (150ml) SILVER SOLUTION **£11.20** + VAT!

POWER CONDITIONER

As featured in ETI, January 1988. The approved parts set contains PCB, case, toroidal cores, class X and Y capacitors, VDRs, ICs, transistors, LEDs, all components, and full instructions.

Parts are available separately. Please send a stamped, self-addressed envelope if you want the lists. Otherwise, an SAE + £1 will bring you lists, construction details and further information.



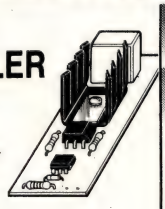
POWER CONDITIONER PARTS SET ONLY £28.50 + VAT

- For those who will only be satisfied with the best
- Use with Hi-Fi, computers, radios, TV sets to eliminate mains-borne interference
- 10 LED logarithmic display shows the amount of interference removed
- Massive filter section with thirteen capacitors and two current-balanced inductors
- Bank of six VDRs to remove transients and spikes
- Suppresses common mode and differential mode interference

Complete Parts Sets for ETI Projects

MAINS CONTROLLER

FEATURED IN ETI, JANUARY 1987



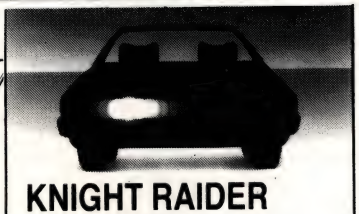
Have you ever wondered what people *do* with all those computer interfaces? 'Put your computer in control,' say the ads. 'The Spectrabeeb has eight TTL outputs.' What on earth can you control with a TTL output? A torch bulb?

The ETI Mains Controller is a logic to mains interface which allows you to control loads of up to 500W from your computer or logic circuits. An opto-coupler gives isolation of at least 2,500V, so the controller can be connected to experimental circuits, computers and control projects in complete safety. Follow your computer interface with a mains controller and you're *really* in business with automatic control!

The mains controller connects directly to most TTL families without external components, and can be driven by CMOS with the addition of a transistor and two resistors (supplied).

Your mains controller parts set contains: high quality roller tinned PCB; MOC3021 opto-coupler; power triac with heatsink, mounting hardware and heatsink compound; all components, including snubber components for switching inductive loads; transistor and resistors for CMOS interface; full instructions.

MAINS CONTROLLER PARTS SET £6.20 + VAT!



KNIGHT RAIDER

FEATURED IN ETI, JULY 1987

The ultimate in lighting effects for your Lamborghini, Maserati, BMW (or any other car, for that matter). Picture this: eight powerful lights in line along the front and eight along the rear. You flick a switch on the dashboard control box and a point of light moves lazily from left to right leaving a comet's tail behind it. Flip the switch again and the point of light becomes a bar, bouncing backwards and forwards along the row. Press again and try one of the other six patterns. An LED display on the control box let's you see what the main lights are doing.

The Knight Raider can be fitted to any car (it makes an excellent fog light!) or with low powered bulbs it can turn any child's pedal car or bicycle into a spectacular TV-age toy!

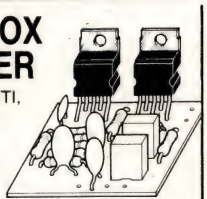
The control box parts set consists of case, switches, LEDs, PCB, components, hardware and instructions. The sequence board includes PCB, ICs, power FETs, components, hardware and instructions.

KNIGHT RAIDER CONTROL BOX ONLY £6.90 + VAT!

KNIGHT RAIDER SEQUENCE BOARD ONLY £13.90 + VAT!

MATCHBOX AMPLIFIER

FEATURED IN ETI, APRIL 1986



No ordinary amplifiers, these. When our first customers took an interest, it was for the diminutive size (both modules will fit in a matchbox!), the total disregard for power supplies and speaker impedances, and the impressive power output from these little amplifiers. When they re-ordered, it was for the sound quality.

Two amplifier modules were described, both based on the powerful L165V IC. The single IC version will deliver over 20 Watts with a suitable speaker and power supply. The bridge version can provide up to 50W! Although the specified supply voltage and speaker impedance must be used to achieve maximum power, both modules are quite happy to work from any voltage between 12V and 32V, and will accommodate any type of speaker. The bridge version is ideal for giving a boost to car Hi-Fi systems, driving two 4 Ohm speakers in parallel on each channel for best effect.

Both designer-approved parts sets consist of a roller tinned printed circuit board and all components. The L165V ICs are also available individually, with a free mini data sheet giving specifications and suggested circuits.

SINGLE IC MATCHBOX AMPLIFIER SET (20W into 4 Ohms)	BRIDGE AMPLIFIER SET (50W into 8 Ohms)	L165V IC, with data.
£6.50 + VAT	**£8.90** + VAT	**£3.90** + VAT

POWERFUL AIR IONISER

FEATURED IN ETI, JULY 1986

Ions have been described as 'vitamins of the air' by the health magazines, and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ionised air is much cleaner and purer, and seems much more invigorating than 'dead' air.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products, was reliable, good to build . . . and fun! Apart from the serious applications, some of the suggested experiments were outrageous!

We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller tinned printed circuit board, 66 components, case, mains lead, and even the parts for the tester. According to one customer, the set costs 'about a third of the price of the individual components'. What more can we say?

DIRECT ION PARTS SET Instructions are included

WITH BLACK CASE **£11.50** + VAT

WITH WHITE CASE **£11.80** + VAT

SPECIAL OFFERS

AD7541 Precision 12-bit multiplying DAC	**£1.20** + VAT
LM3524 Switch mode regulator IC	**£0.80** + VAT
CF585 Calculator IC	**£1.00** + VAT
LM339 Quad comparator IC	3 for **£1.00** + VAT
MC1458 Dual op-amp	3 for **£1.00** + VAT

All ICs supplied with **FREE DATA**.
Prices apply only while stocks last.

LM2917 EXPERIMENTER SET

Consists of LM2917 IC, special printed circuit board and detailed instructions with data and circuits for eight different projects to build. Can be used to experiment with the circuits in the 'Next Great Little IC' feature (ETI, December 1986).

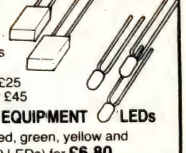
LM2917 Experimenter Set £5.80 + VAT

RUGGED PLASTIC CASE

suitable for mains conditioner and mains controller.

ONLY £1.65 + VAT

LEDs



Green rectangular LEDs for bar-graph displays.

50 for £3.50 500 for £25

100 for £6 1000 for £45

DIGITAL AND AUDIO EQUIPMENT LEDs

Assorted 3mm LEDs: red, green, yellow and orange. 25 of each (100 LEDs) for **£6.80**

Prices shown are exclusive of VAT, so please add 15% to the order total. UK postage is 70p on any order. Carriage and insurance for overseas orders £4.50. Please allow up to 14 days for delivery.

Specialist SEMICONDUCTORS LIMITED

SALES DEPT.
ROOM 108
FOUNDERS HOUSE
REDBROOK
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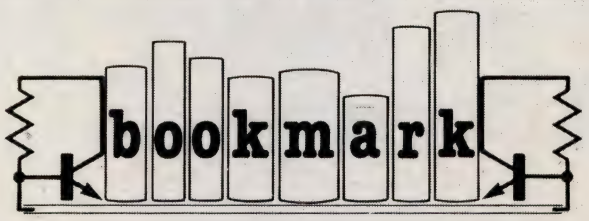
GWENT



Another selection of newly published books to while away the rainy days.

Audio Amplifier Fault-Finding Chart. C.E. Miller. Babani BP120. 95p. ISBN 0-85934-095-3. This is not a book, but a chart that has been designed to help the reader approach fault finding in audio amplifiers in a systematic and logical way. It claims to also assist in the repair of equipment, and this it does to the extent that some items, such as fuses or faulty mechanical parts, can be located and replaced by the non-technical. More technical aspects of amplifier problems though, like electronic component checking, needs far more data than this chart has room to provide. Nonetheless, at 95p, many will find it a useful guideline.

BBC Basic86 On The Amstrad PCs and IBM Compatibles. Book 1 – Language. N. Kanaris and K. Thompson. Babani BP243. £3.95. ISBN 0-85934-188-7. The book is specifically designed for use with the above titled computers that can run BBC86. The latter is the structured language that many users of the BBC computer will have come to know. Statements in this language are introduced and explained with the help of simple programs. This is intended to enable the user to build up a considerable library of programs and procedures, which in turn could become the building blocks of advanced programming techniques. As a programmer who taught himself the art through reading books and experimenting, your Ed recognises that any like-minded person will eagerly acquire practically any book on the subject. However, my reaction to this one is 'so what's new?'. Paging through, I feel that I've seen it all before, and more comprehensively done.

Electronic Hobbyists Handbook. R. Penfold. Babani BP233. £4.95. ISBN 0-85934-178-X. We have come to expect well written and informative books from Robert Penfold, and this one is no exception. It offers a source of easily located information that many electronics enthusiasts may often need. It covers colour codes, characteristics and pin outs of many popular semiconductors, and illustrates many simple circuits. It also contains other useful data, such as circuit symbols, interface details, amateur and CB frequency allocations.

An Introduction to the Amstrad PCs. R.A. and J.W. Penfold. Babani BP197. £5.95. ISBN 0-85934-172-0. Specifically written for the PC1512 and PC1640, this book is aimed at those who have little or no previous knowledge of computing, and shows that using a business computer is a lot less difficult than many people may imagine.

The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects. G. McComb. Tab Books. £12.00. ISBN 0-8306-2800-2. In over 300 pages, the book shows how you can build and combine the various parts that make up a robot, and to create your own original, custom designed, personal robot. If you love using your hands and your brain, you will find much pleasure from this book of mechanics and electronic circuits. It also gives a list of tools and equipment, a logic interfacing guide, and a drill bit and bolt chart. Beware that the addresses given for mechanical parts sources are all in the USA, though it seems likely that equivalent UK suppliers will exist.

An Introduction to Control and Measurement with Microcomputers. R.L. Dalglish. Cambridge University Press. £15.00. ISBN 0-521-31771-1. The book is intended to be a complete introduction to microcomputers and their application to control and data acquisition, and attempts to simply and clearly describe how microprocessors work and the basic architecture of a microcomputer. Since the book is based on courses given by the author for undergraduates, professional scientists and engineers, it is not so well suited for the early beginner, nor should it be regarded as a constructional guide.

44 Power Supplies for Your Electronic Projects. R.J. Traister and J.L. Mayo. Tab Books. £12.85. ISBN 0-8306-2922-X. The book claims to be a 'treasury of high- and low-voltage power supplies for all types of electronics applications'. As interesting as the book is, I feel that it does not live up to this claim, and I am aware of quite a few other types of power supply that I believe should have been included. I am also concerned that transformer-less mains operated supplies are recommended without, in my opinion, sufficient warnings about the potential safety hazards entailed. Aside from these niggles, the book does have some very useful information on power supply theory and applications that will be beneficial to many constructors.

State of Solid State. Tab Books. £7.75. ISBN 0-8306-2733-2. Written by the editors of the American magazine Radio-Electronics and comprises a selection of their articles published between 1982 and 1985. They include semiconductor theory, information on various solid state devices, and projects that use them. Some aspects of electronic technology may not change, but others are in a constant state of improvement; consequently I feel that articles going back to 1982 may only be of historic interest. There is the additional danger that some of the specified components may be unobtainable to UK readers, either because they have now become obsolete, or because the quoted suppliers are in the USA. The fact that original dates of publication for the articles are not given, and the use of statements within the text like "...catalogue is a new (1983) edition..." give me some cause for concern.

Solid-State Electronics Theory with Experiments. M.J. Sanfilippo. Tab Books. £13.20. ISBN 0-8306-2926-2. This book should be of interest to those who want to know more about the hows and whys of semiconductor devices. It ranges from the basic concepts, through diodes, transistors, and opamps through to initial considerations of integrated circuit technology. It is well filled with drawings, but keeps formulae to a minimum. Experiments are included and are designed to complement the topics. Although the book originates from the USA, its appeal will be far more international.

An Introduction to 8086/88 Assembly Language Programming for Engineers. N.M. Morris. McGraw-Hill. £12.95. ISBN 0-007-084173-X. In addition to dealing with the principles of programming, this book also provides a range of carefully designed programs, introducing readers to the arithmetic and text handling capacities of the chip. The programs are presented in a 'recipe' form, so making programming easier to learn. The book also describes the use of practical interrupt programs, and covers both digital and analogue input and output. Those studying 16-bit programming will find this book particularly useful.

The Real Hi Fi Story, P. Herring. The British Audio Dealers Association and the Federation of British Audio. A beautifully produced promotional book published by the BADA and available **FREE OF CHARGE** (though for some reason it has £2.50 marked on the cover) from **The Sound Advice Centre**, 40-41 Great Castle Street, London W1N 7AF. It measures just over 12 x 12 inches (about 32 x 32 cms) and has 24 pages split into two sections, one covering advice on hi fi facts, the other a selection of post-paid advertiser's reply cards. It is in full colour and should delight anyone who needs basic advice on the nature and requirements of hi fi equipment. There are also generous offers on trade-in equipment and special finance available, so it could help you to enjoy your music and save money into the bargain. Hurry though, for it published as part of a promotional campaign to increase the public's awareness of quality hi fi and specialist retailers, and as such may be in limited supply.

Normal good book shops should be able to get the books for you, but in the case of difficulty, these are the publisher's addresses:

Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge, CB2 2RU.

Tab Books – through John Wiley & Sons Ltd, Baffins Lane, Chichester, W. Sussex, PO19 1UD.

Babani Books, The Grampians, Shepherds Bush Road, London W6 7NF.

McGraw-Hill Book Company, Shoppenhangers Road, Maidenhead, Berks. SL6 5BR.

READERS' LETTERS

FROM FRED

Dear John,

Congratulations on the fine job you are doing with PE. Until seeing the Jan 88 issue, I had been out of touch with PE since it moved to Poole many years ago. It is nice to know that it is still thriving as a London based mag once again and under the very capable hands of one of its old contributors! I remember very well the occasion in 1971 when you demonstrated your Telephone Answering Machine in our workshop at Fleetway House. That was the start of a good relationship which was to prove rewarding to PE and, I trust, to yourself over the years.

I wish you all success in 1988. Keep up the good work.

Fred Bennett, Middx.

Many readers of PE will well remember that Fred Bennett was the founding Editor of PE in 1964, building its success until Mike Kenward took over when PE moved to Poole at the end of 1977.

We are proud to have Fred's approval for our style of publishing PE. Many readers, as well as myself, greatly benefitted from his capable and kindly editorship. Had it not been for his influence, it seems possible that my own interest in electronics might not have flourished, nor would I now be following in his editing footsteps.

Fred set the standards, the goals and the achievements; I hope that I too may likewise influence many of you in your appreciation of a worthwhile and exciting technology.

Thanks Fred, and best wishes. **Ed.**

BUSH TELEPHONES

Dear John,

I was most interested by the *Recalling History* article in PE Dec 87, particularly the way it was written in the past tense. Overhead phone lines with transpositions are alive and well here in South Africa.

Our telephone is still a magneto instrument with local battery. The 'local' operator switchboard is 55 miles away, mostly by overhead lines. There are also some 10 subscribers on the same line, so we have code-ringing to see who the incoming call is for (my code is short-long-long). Nevertheless, the system works well and conversations are 'loud and clear'.

Atkinson (*Telephony Vol 1,* Pitman 1948) states 'where it is not practicable to provide lines of the requisite standard of insulation and ohmic resistance... the magneto system is still probably one of the most practicable methods of signalling'.

Even calls to overseas countries come over very well. When one considers the thousands of contacts, wire joints, relays, up-links and down-links to satellites and so on, one cannot be critical of the service.

One slight disadvantage of the long overhead lines is that when lightening flashes all the bells tinkle!

In fairness to the post office, they have promised us an automatic service later this year. But they said that last year too!

R.H. Shepperd, Darlington, South Africa.

One of my mottos is "never interfere with a working system" Unless profound benefits are likely to ensue, if something works, however archaic it may be, why change it? We are sometimes brainwashed into thinking that all technological advances should be implemented. It ain't necessarily so! **Ed.**

MICROJAM

Dear Ed,

I sympathise with Mr Gough whose letter concerning radio jamming you published in PE Jan 88.

It would seem that in some way my neighbours are using computers which are interfering with my vhf radio reception. Is it legal for them to do so?

Name and address supplied.

Many types of electronic circuitry can emit electromagnetic radiation, computers included. My own interferes with a small vhf radio I have when it is within a couple of feet of the computer, especially when putting data out to disc. I understand that in the world of espionage (dare I mention that these days?), it is possible to 'eavesdrop' on a computer by monitoring its radiation with highly sensitive and specialised equipment.

It is also well known that tv receivers radiate their own signals, which is how license dodgers can be caught out by detector patrol vans.

Under normal use, domestic equipment is unlikely to be radiating with a power sufficiently strong to contravene regulations, but anyone who believes that a neighbour is allowing radio interference to occur should follow the advice I gave in Jan 88 – contact the Radio Investigative Service of the Department of Trade and Industry through the local post office. **Ed.**

MAINTAINED

Dear Ed,

Having decided to refresh my rusty electronics knowledge as I am deeply into microcomputers and their applications, I recently bought a copy of PE after not having taken it for a considerable number of years. May I say how pleasantly surprised I was to find such a high standard of editorial and technical content. What a highly readable mag it still is.

Please help me on two questions. I have many computer items each running off separate transformers, can I run them all of one transformer via DIN connectors? Secondly, I have read a lot of warnings regarding destroying chips with static electricity. What sensible precautions should one take, and which is the best practical earthing method?

I look forward to reading your mag regularly in the future.

T.G. Colledge, Chester.

Welcome back. Providing the transformer chosen is capable of delivering the correct voltage at the correct current you should have no difficulties in unifying your system, as long as you also ensure that the connecting cable is capable of carrying the current to avoid voltage drops with changes in load. The connecting plugs and sockets should also be chosen with good regard for the current drawn. I assume you refer to DIN style audio connectors – these can carry 100Vac or 150Vdc at 2A.

Much has been written about static problems and avoidance. There are many methods used commerically to ensure that static is not experienced, ranging from antistatic clothing, floorcoverings and so on, to operator earthing straps and pads. For the casual home constructor the simplest method is to periodically touch the conductive surface of something that is known to be earthed. The metal body of an earthed soldering iron is probably the most convenient item regularly at hand. You don't need to hold it, just touch it briefly every few minutes, especially if you are moving around in nylon or other static generating clothing. Chips are far hardier than many people give them credit for, and if you handle them sensibly it is unlikely that you will kill them. **Ed.**

POP PICKING RADIO

Who would have believed that an April Fool text could take on reality? Some time ago I was shown an amusing tongue-in-cheek speculative article concerning radios that could automatically select the type of programme transmission you most wanted to tune into. A recent report says that such radios will become available during this year.

The report states that these radios will initially be for in-car entertainment and will find the type of programme you want, whether it is jazz, chat, drama, sport, news or classics, irrespective of which station is transmitting it.

The facility is becoming possible because of a development called the Radio Data System. This is computer controlled and sends out a coded signal with transmitted programmes that enables the radio to search out the particular code relating to your listening preference.

Additional facilities offered by RDS include searching out traffic reports, and even paging individual listeners in emergencies. The road report service comes as no surprise since some radios in new cars (including my own) have a button that is intended to activate a search facility.

RDS is being introduced by the European Broadcasting Union and at least 11 countries are likely to introduce it over the next two years. Apparently the BBC are ready to do so now, and that they regard RDS as "the most significant advance in radio technology since the introduction of stereo broadcasting".

Once again it seems that SF is becoming science fact, and that even AF texts may sometimes be based on reality. I can't help but wonder if research scientists don't sometimes get their inspiration from authors like Daedalus of *New Scientist*, Arthur C Clarke, Isaac Asimov, Brian Aldiss, Larry Niven and other such heroes of mine. **Ed.**

TEACHER COUNTER

PART ONE BY TIM PIKE

The last in a series of projects aimed at students of GCSE Electronics preparing for project work for examination this year.

Tim Pike analyses a seven segment display and the logic needed to drive it, with the help of Boolean algebra and Karnaugh maps. Why do things the hard way? Because it makes the easy way easier. The result is an event counter.

IN this the seventh and last constructional article in the present series, I have decided to return to my favourite branch of the subject. Readers who have followed the series will recall that in the second article, '*Teacher Locker*' (PE Oct 87), I looked at some of the principles of digital electronics and specifically at the use of logic devices. In designing the circuit for the simple digital lock, a combination of discrete devices and integrated circuits was used to provide both the desired logical function and the necessary timing and ordering of events.

In commercial design, it is unlikely that such a proportion of discrete devices would be used. If the complete design could not be produced by a combination of standard integrated circuits with just a minimal number of discrete devices to support them, then a specialised integrated circuit would be designed to meet the exact needs of the particular application. Almost inevitably such a device might possess both digital and analogue facilities.

In order to justify the relatively high costs involved in developing such a device, one would need to be fairly sure of commercial success. It is hardly likely that a circuit simple enough to form the basis of a GCSE project is destined to receive such acclaim, no matter how useful it might be!

In this last article, I hope to extend the introductory work on logic contained in the October 87 article and to use these ideas to decode a standard seven segment display. By adding a binary counter, I will produce a simple multi-purpose event counter.

THE SEVEN SEGMENT DISPLAY

In order to define the system which we require the logic to produce, let us begin by examining the output device in detail.

A seven segment display consists of seven separate light-emitting diode elements arranged in a figure of eight such that all ten decimal digits can be displayed, together with many other patterns.

Each diode element would seem to require two connections (anode and cathode) but it is possible to reduce the total from fourteen to eight by making all segments share one connection. There are therefore two possibilities: common anode types in which the seven cathodes are each separately available together with one shared anode connection or the opposite (common cathode types) where the seven anodes are separately available together with one shared cathode connection. For many applications, it does not matter which type is chosen.

It is of course always important to know which type is in use to avoid problems of incorrect polarity when the device is put into the circuit.

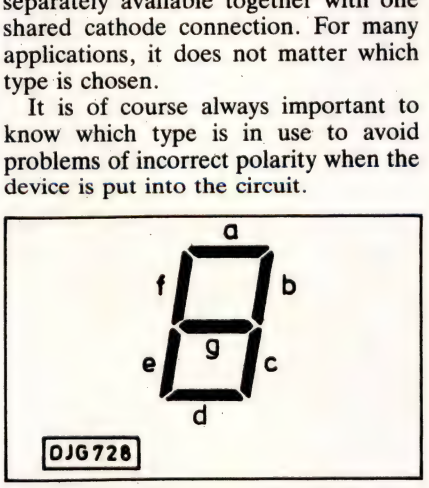


Fig 1. *Seven segment arrangement*

Fig.1 shows the standard arrangement of segments (labelled a to g). Fig.2 shows the pin-out for a common anode display

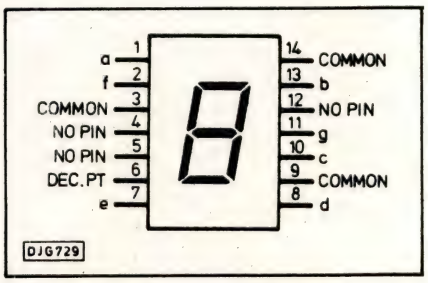


Fig 2. *Typical common-anode pin-out.*

contained in a standard dil (dual-in-line) package. Note that in addition to the seven segments there is also a further led unit to provide the option of a decimal point. The three pins marked 'common' are all connected to the anodes of all led segments.

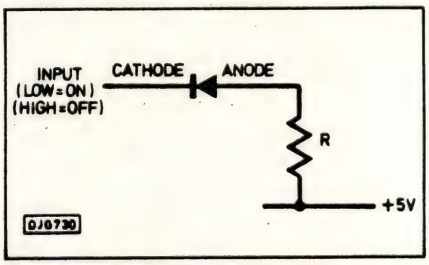


Fig 3. *Single segment drive*

In order to turn on any one segment it is necessary only to lower the voltage on the cathode of this segment below the common anode voltage by about +2V. The required forward current to illuminate one segment to a specific level of brightness will depend upon the physical dimension of the display and upon the colour of the display segments. A series resistor of appropriate value will be needed for each segment to limit the current. In practice, one resistor may sometimes be used for all segments where consistency of brightness level is considered to be unimportant. Values between 82Ω and 330Ω for 5V operation are common. Considering just one segment as if it were a discrete led, Fig.3 shows how it can be turned on or off by driving the input voltage to the cathode low or high.

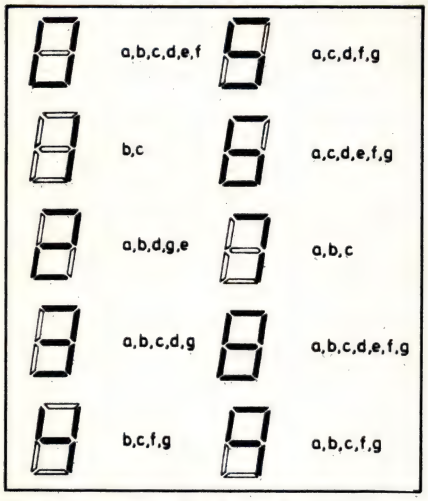


Fig 4. *Segments for digits 0 to 9*

PRODUCING DECIMAL DIGITS

Now that we have control of each segment independently, our next concern is to form intelligible symbols by combining the segments to form the familiar shapes of the ten decimal digits (0 to 9).

Examination of the way in which the digits might be represented allows us to determine which segments must illuminate for each digit.

Fig.4 shows the details. Of course, these ten patterns are but a few of the total number of arrangements which could be produced. For those readers with a mathematical interest, each of the seven segments can be either on or off. There are, therefore, 2^7, or 128 possible arrangements, including the two extreme cases of either all segments OFF or all segments ON (the digit 8). Some of the other 118 arrangements can be useful in certain circumstances. Some letters of the alphabet can be created either in lower or upper case. This facility is commonly used to represent numbers in hexadecimal (hex) which is base sixteen. Hex requires six additional symbols to represent the decimal values from ten to fifteen. The first six letters of the alphabet may be conveniently used. For reasons which are obvious when the seven segment display is examined, some of these six letters must be represented as capitals and some must be represented in their lower case form. The symbols used are A, b, c, d, E and F.

To return to the production of the decimal digits let us consider as an example, how the symbol for the digit '3' must be created.

From Fig.4, we see that we need to drive the five segments a, b, c, d and g. Each of these five segments can be considered as an output from our system. The inputs to the system will be the outputs from a binary counter, set to count from zero to nine.

In order to represent the ten decimal values from zero to nine, a four-bit binary code will be required. In this number system, the value for decimal '3' is 0011. We therefore have four inputs (one for each column of the binary code). If we call these inputs A, B, C and D, where A represents the least significant bit (lsb), then this particular combination of inputs must produce the correct pattern of outputs in order to drive the display.

Fig.5 shows the generalised system diagram to produce the logic circuitry which links the binary counter to the seven segment display. Fig.6 shows the system diagram with the inputs and outputs required to produce the decimal value '3'. Here we have assumed that the input to a segment must be high to turn on that segment.

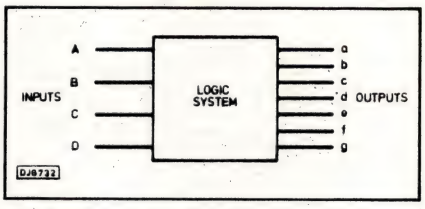


Fig 5. *Generalised logic system*

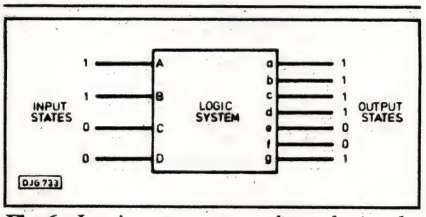


Fig 6. *Logic states to produce decimal digital "3".*

Clearly we could design a separate logic system for each of the ten output states. It should be possible to economise, however, and to consider all ten requirements simultaneously.

The table in Fig.7 relates all ten input states to their corresponding output states. One of the advantages in presenting the information in this form is that it allows us to define, for each output, the particular combinations of inputs which require the output to be on.

Consider the output which will drive segment 'a'. 'a' must be on for the 0, 2, 3, 5, 6, 7, 8 and 9 states. It is common practice to represent this relationship by writing an equation. The equation states all the input states which produce a certain output state.

BOOLEAN ALGEBRA

In order to specify the equation in an abbreviated form, we use a type of algebra which is named after George Boole, the 19th century English logician, who first proposed this method.

In this algebra, the standard logic functions are represented by symbols which link the input variables together.

AND is represented by a dot (.)
OR is represented by a plus sign (+)
NOT is represented by a bar over the variable e.g. $\bar{A}$ means NOT A

(Whatever possessed a logician not to define AND as '+', a symbol which in language terms means 'and'? Ed).

So, to express 'A AND B AND C' we simply write A.B.C. To express 'A AND NOT B', we write $A.\bar{B}$.

To express 'B OR C OR NOT D' we write $B+C+\bar{D}$.

Looking back at Fig.7 to the output column for segment 'a', we see that eight of the ten input combinations will turn segment 'a' on. We could therefore write down that 'a' is to come on when the inputs register 0 or 2 or 3 or 5 or 6 or 7 or 8 or 9. In Boolean algebra this would be written as:

$$a = \underset{\text{(zero)}}{\bar{A}.\bar{B}.\bar{C}.\bar{D}.} + \underset{\text{(two)}}{\bar{A}.B.\bar{C}.\bar{D}.}$$

$$+ \underset{\text{(three)}}{A.B.\bar{C}.\bar{D}.} + \underset{\text{(five)}}{A.\bar{B}.C.\bar{D}.}$$

$$+ \underset{\text{(six)}}{\bar{A}.B.C.\bar{D}.} + \underset{\text{(seven)}}{A.B.C.\bar{D}.}$$

$$+ \underset{\text{(eight)}}{\bar{A}.\bar{B}.\bar{C}.D.} + \underset{\text{(nine)}}{A.\bar{B}.\bar{C}.D.}$$

The same method could be applied to the other six outputs (b to g). Each of these would generate an equation in Boolean algebra. These seven equations will completely define the operation of the seven segment display as it counts from zero to nine.

Fig 7. *Truth table of input and output states*

D	C	B	A	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	1	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	0	0	1	1

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SIMPLIFICATION

Considering just the output to segment 'a', we could produce a logic design to implement this equation directly.

We would require:

4 NOT gates (one for each variable, A to D).

8 AND gates (each having four inputs).

1 OR gate (with eight inputs!).

This would need at least six integrated circuits. Assuming that the other six output segments would require much the same amount of logic circuitry, we would seem to need about forty integrated circuits!

Clearly, this is ridiculous. Readers who are familiar with seven segment display devices will know that the complete display driver circuitry is available on one integrated circuit. In normal circumstances one would simply select and use one of these devices. However, since we are interested in learning about the way in which logic can be used to solve problems, it does not suit our purpose to be so pragmatic at this stage. We must find a method of simplification which will lead us to a solution which we have developed ourselves, and therefore which we understand, and yet is simple enough to be practicable to construct.

Let us look again at the equation for segment 'a'. Notice that the term which represents the zero state ($\overline{A}.\overline{B}.\overline{C}.\overline{D}$) and the term which represents the eight state ($\overline{A}.\overline{B}.\overline{C}.D$) are identical except for the variable D.

One method of simplification which will be familiar to GCSE students of mathematics is to regroup the terms in the whole expression and then to 'factorize' and collect like terms.

e.g. $\overline{A}.\overline{B}.\overline{C}.\overline{D}. + \overline{A}.\overline{B}.\overline{C}.D. = \overline{A}.\overline{B}.\overline{C}.(\overline{D}+D)$

and by the basic rules of binary arithmetic, $(D+\overline{D})$ must be equal in value to '1'.

So these two terms simplify to $(\overline{A}.\overline{B}.\overline{C})$ the further conjuction with '1' being redundant.

A similar process could be used to simplify the terms representing the six state ($\overline{A}.B.C.\overline{D}$) and the seven state ($A.B.C.\overline{D}$), resulting in just one term, ($B.C.\overline{D}$).

Although this is an effective technique, it is rather slow and not guaranteed to produce the simplest overall expression for 'a'.

THE KARNAUGH MAP

Students of electronics who decide to take their studies beyond GCSE level will later meet a much more powerful technique which gives *the simplest* expression for any logical function if used correctly. The method is essentially a graphical or perhaps a pictorial one.

Looking back again at the table in Fig.7, we understand that with four input variables, there are actually sixteen combinations, the highest binary value being 1111 (or 15 in decimal). We chose to ignore the values from ten onwards, as they would not be present in a decimal count, to one digit. However, before we explore the opportunities offered by the Karnaugh Map, we need to be clear that these other six binary states can exist in an 'imaginary' way if we wish to include them.

Ultimately we will be using a binary counter to generate the inputs A,B,C and D and resetting the counter on the tenth pulse. So, although the binary codes from 1010 to 1111 will not exist as outputs from the counter we could include them in the picture and make them generate outputs to suit the simplification process, knowing that the state of these last six outputs does not matter as they will never appear on the display. Bearing this in mind, let us look at the structure of a Karnaugh Map.

There are a number of simple rules which become obvious once you begin working with these maps.

1. The map will be a rectangular (or square) grid of boxes.
2. There must be one box for each possible combination of inputs. In our case, there are 16 combinations, so there must be 16 boxes. In general there will be 2^N boxes where N is the number of inputs.
3. Each box must have a unique label which refers to its particular input combination.

Fig.8 shows the grid of 4 by 4 boxes and one method of labelling. Notice that the left-hand two columns are representing input A, the right-hand two are therefore NOT A. The centre two columns represent B, the outer two are therefore NOT B. The same ideas apply to the rows for C and D. If you care to check the labelling, you will find that every box represents a different combination of inputs.

COMPLETING THE MAP

There is only one rule for completing the map. Wherever there is a '1' in the input-output chart (Fig.7) or truth-table, a '1' must be placed in the corresponding box on the map. We already know that there are eight '1's for output 'a'. So the map for output 'a' will look like Fig.9.

There are only two known zero outputs — they occur for the states representing 1 and 4. So these can be

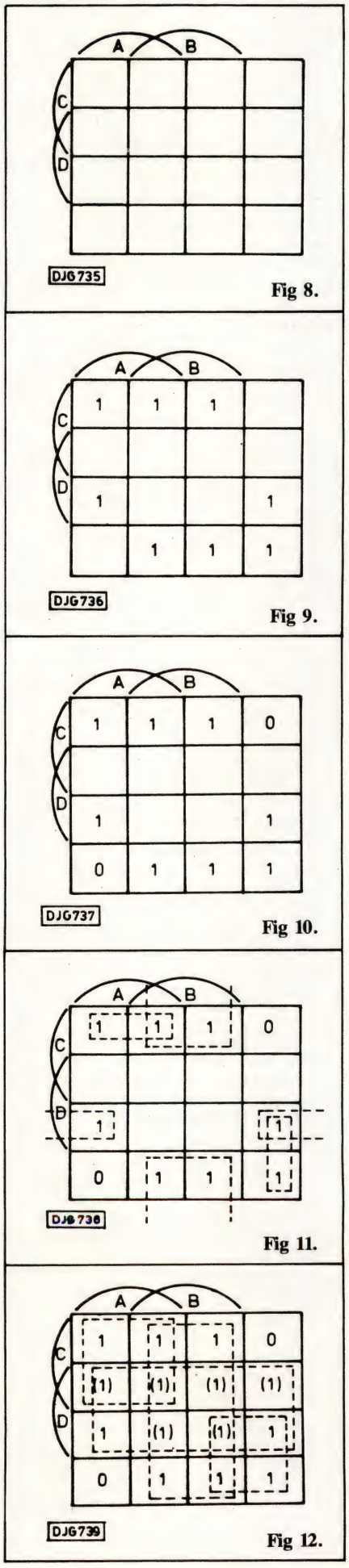

Fig 8. *Empty Karnaugh map for a four-variable logic function.*
Fig 9. *Map for output segment "a" (required "1" and "0" states).*
Fig 10. *Map for segment "a" (known "1" and "0" states)*
Fig 11. *Use of wrap-around effect to obtain larger groups of boxes.*
Fig 12. *Completing the map with "imaginary" states.*

added to the map (Fig.10). The remaining six boxes represent the binary combinations from 1010 to 1111. Since we are not going to allow these to exist in our counter, it does not matter whether they generate a zero or a one.

READING THE KARNAUGH MAP

So far so good (I hope!). The really clever part about the Karnaugh Map method comes when we read off the information. The strategy is to read off blocks of information rather than single box labels. There are however two or three rules:

1. The groups of boxes must be rectangular groups (i.e. not diagonals).
2. The groups must be binary groups (i.e. one box, two boxes, four boxes, eight boxes etc.).
3. The groups must be as large as possible. Large groups have simple labels.

To help with this process it is useful to remember that the top and bottom of the map are really joined; so too are the left and right edges. This is called the 'wrap-around effect'. It is fairly clear from Fig.10 that the largest group we can obtain is a group of four boxes containing 1s as shown in Fig.11. This group requires the use of the 'wrap-around effect'.

The label for this group is $(B.\bar{D})$. So this will be one term in our simplified expression for segment 'a'. We must read off all the boxes to obtain the full expression and we can include some of them more than once if we wish.

With the map as it stands, there are no other groups of four 1s. The best we can do is to form three other groups, each of two boxes, to cover all the "1 boxes". There is more than one way of doing this but the net result is a final expression for 'a' such as:

$a = B.\overline{D} + A.C.\overline{D} + \overline{A}.\overline{B}.\overline{C} + \overline{B}.\overline{C}.D$

or $a = \overline{D}.(A.C. + B) + \overline{B}.\overline{C}.(\overline{A} + D)$.

Although very much simpler than the original expression, this will still require the following gates:

4 NOT gates (1 for each variable).
+ 3 AND gates } or { + 4 AND gates
+ 3 OR gates } { + OR gate.

We would still need three or four integrated circuits to implement this solution.

INCLUDING THE 'IMAGINARY' STATES

Looking at the Karnaugh Map of Fig.10 again, it is fairly clear that if we had more boxes with 1's in them then we could write a much simpler expression.

In fact if we fill in all the other unused boxes with imaginary 1's then a very much simpler expression results. Fig.12 shows the original map plus the imagined states in brackets.

There are now two groups of eight boxes (B and D), leaving only the two corners of the principal diagonal to be included. These can be incorporated into two groups of four boxes. One corner is included in the group (A.C) and the other in the group $(\bar{A}.\bar{C})$.

The final expression which will drive segment 'a' correctly up to decimal 9 is:–

$a = B + D + A.C. + \bar{A}.\bar{C}$

This can be produced with just:

2 NOT gates
2 AND gates
1 OR gate.

The logic circuit design is shown in Fig.13.

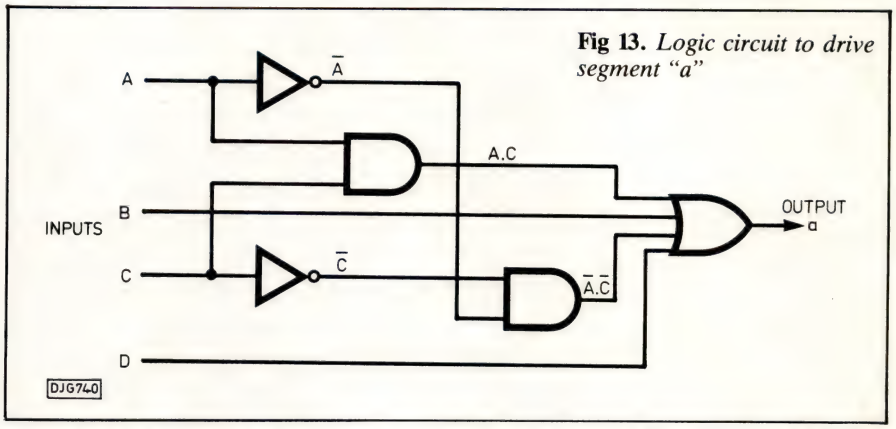

Fig 13. *Logic circuit to drive segment "a"*

FURTHER ECONOMIES

Now that we have reached this level of sophistication it becomes obvious that we would be wasting integrated circuits if we were to use three different devices to produce this circuit.

Another fascinating aspect of logic design is that any Boolean expression can be implemented entirely from NAND gates or entirely from NOR gates.

NAND gates are a little easier to work with, starting from the Karnaugh Map. The simple expression above for 'a' can be re-written to suit NAND gates very easily indeed.

De Morgan's theorem states that:–

$\bar{A}.\bar{B} = A + B$ (NOR)

and

$\bar{A} + \bar{B} = A.B$ (NAND)

By applying a double inversion to the whole of the right hand side of the equation for 'a',

$a = B + D + A.C + \bar{A}.\bar{C}$

We are then able to apply De Morgan's theorem to obtain:

$a = \bar{B} \,.\, \bar{D}.\, A.C \,.\, \bar{A}.\bar{C}$

Although this appears to be more complicated than the simple expression obtained from the Karnaugh Map, it does only require NAND gates. Namely:

4 NOT gates (which can be NAND gates).
2 two input NAND gates.
1 four input NAND gate.

Perhaps the NOT gates are best produced from a simple hex inverting device because of its ease of use. We will then need one inverting gate device plus half of each of the two types of NAND device. The best circuit design for output 'a' with just two types of gate is shown in Fig.14.

EXTENDING TO ALL SEGMENTS

Exactly the same analysis for segments b to g produces the results shown below. I will leave it to you to verify that these Boolean expressions are correct!

$b = A.B. + \bar{A}.\bar{B} + \bar{C} + D$
$c = A + \bar{B} + C + D$
$d = \bar{A}.B + \bar{A}.C + A.\bar{B}.C + B.\bar{C}$
$e = \bar{A}.B + \bar{A}.\bar{C}$
$f = \bar{A}.\bar{B} + \bar{A}.C + \bar{B}.C + D$
$g = \bar{A}.C + B.\bar{C} + \bar{B}.C + D$

A quick glance at this set of equations reveals that a number of the terms within them occur more than once. For example $(\bar{A}.C)$ occurs three times. Clearly we can economise in another way by utilising the same section of circuitry each time a particular term is needed.

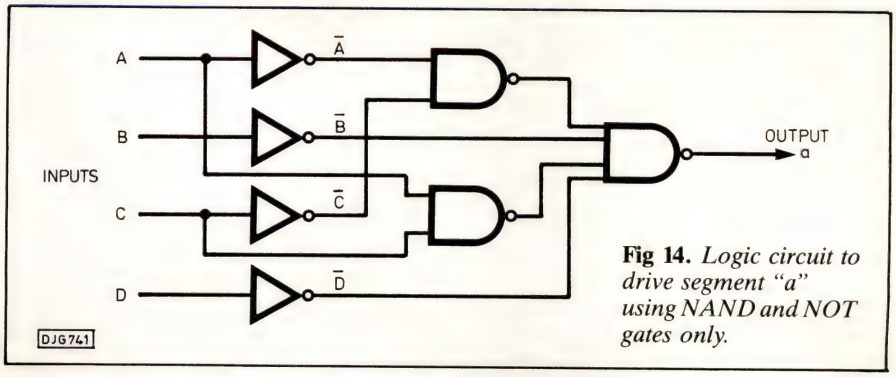

Fig 14. *Logic circuit to drive segment "a" using NAND and NOT gates only.*

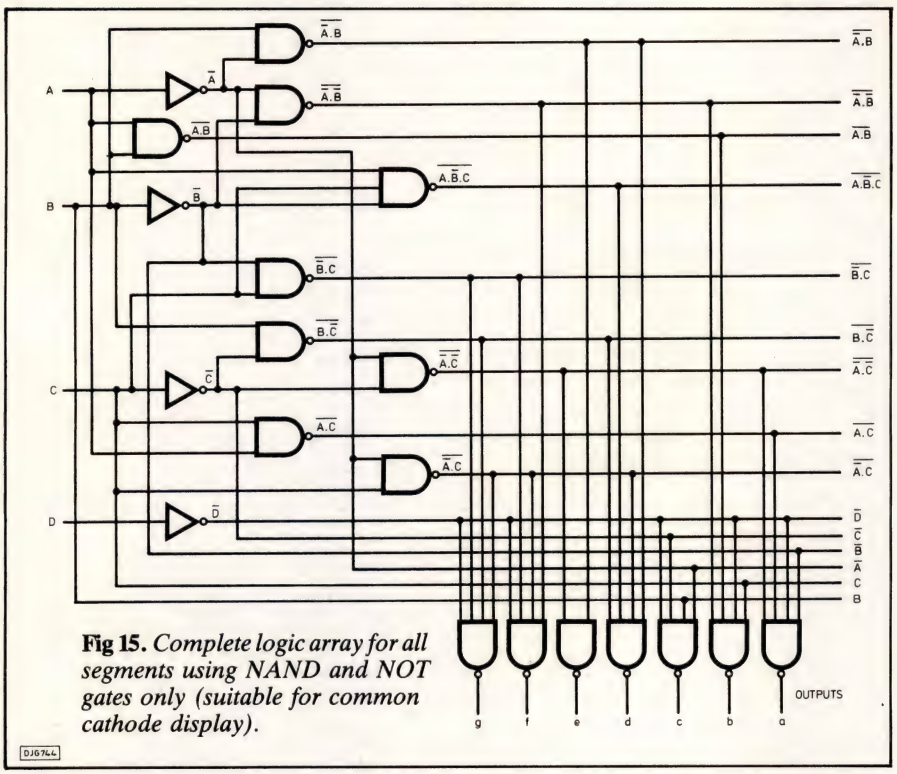

Fig 15. *Complete logic array for all segments using NAND and NOT gates only (suitable for common cathode display).*

Converting these expressions to NAND and NOT only generates the full set of equations given below:

$a = A.C \cdot \bar{A}.\bar{C} \cdot \bar{B} \cdot \bar{D}$

$b = A.B \cdot \bar{A}.\bar{B} \cdot C \cdot \bar{D}$

$c = \bar{A} \cdot B \cdot \bar{C} \cdot \bar{D}$

$d = \bar{A}.B \cdot \bar{A}.C \cdot A.\bar{B}.C \cdot B.\bar{C}$

$e = \bar{A}.B \cdot \bar{A}.\bar{C}$

$f = \bar{A}.\bar{B} \cdot \bar{A}.C \cdot \bar{B}.C \cdot \bar{D}$

$g = \bar{A}.C \cdot B.\bar{C} \cdot \bar{B}.C \cdot \bar{D}$

COUNTING THE COST

A tally of the gates used in Fig.15 shows that we require:

4 × NOT gates
9 × two input NAND gates
1 × three input NAND gates
6 × four input NAND gates.

The most economical way of producing this circuit would require the use of:

1 × hex inverting integrated circuit
2 × two input NAND gate integrated circuits
1 × three input NAND gate integrated circuit
3 × four input NAND gate integrated circuits.

Throughout this analysis, we have assumed that we need to produce a logic 1 to turn on the disply. If this is not so, then the output must be inverted before being presented to the display.

Many readers may well feel by now that the complexity of the design in Fig.15 is not justified when one recalls that a single specialist integrated circuit can be purchased to perform this very function. Certainly only the most able GCSE candidates should consider building the logic array in Fig.15. The alternative is to use a display driving chip. Whichever option is chosen, I hope that the analysis of the logic array is useful to all budding digital electronic engineers. At the very least it gives a much better appreciation of the sophistication of the display driving chip.

FULFILLING THE ORIGINAL DESIGN BRIEF

One very important aspect of all project work for examinations in electronics is that the final circuit must fulfil the original objectives. In order to create a simple event counter we need to add a four-bit binary counter, resetting on its tenth pulse and a means of clocking the counter. A complete system diagram is shown in Fig.16.

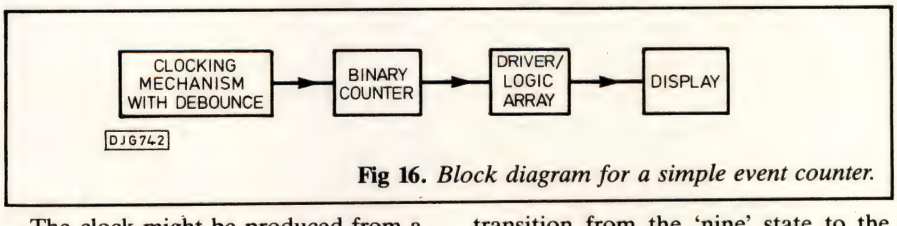

Fig 16. *Block diagram for a simple event counter.*

The clock might be produced from a square wave generator running on its lowest frequency or perhaps more easily from a manual switch. A simple push to make switch or even a microswitch will often suffer from 'contact bounce'. This phenomenon results in multiple pulses being entered when in fact only one pulse was intended. It can be overcome by incorporating an anti-bounce circuit between the switch and the clock input

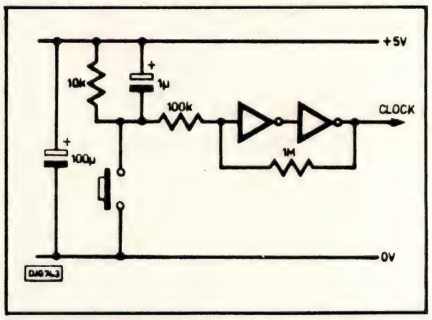

Fig 17. *Simple switch anti-bounce circuit*

to the binary counter. A pair of hex inverters with resistive feedback (forming a Schmitt trigger) connected as shown in Fig.17 offers one type of anti-bounce circuit. Cmos inverters are more likely to work well in this situation. The 100μf capacitor acts as a large reservoir of charge to help to avoid pulses appearing on the supply rails.

ALTERNATIVE TRIGGER MECHANISMS

Our simple event counter can easily be adapted to count pulses of a different nature if an appropriate transducer and switching circuit is added.

Some ideas might include an optically triggered switch based on an ldr, a photo-diode or a photo-transistor, or a magnetically operated switch based perhaps on a reed relay.

COUNTING LARGER NUMBERS

The other likely improvement which we should consider is how to adapt the ideas given so far to extend the range of the counter. Certainly it would be useful to count from 0 to 99, if not to 999 or more. Each additional decimal column requires an extension to the binary counter. If we are to retain the use of the logic array developed in Fig.15, then each subsequent decimal column will need its own four-bit binary counter connected to reset on its tenth pulse. The second column counter will be clocked either from the reset pulses to the first counter or by recognising the transition from the 'nine' state to the 'ten' state of the first counter.

In Part Two next month the circuit for a practical event counter will be shown, complete with constructional details.

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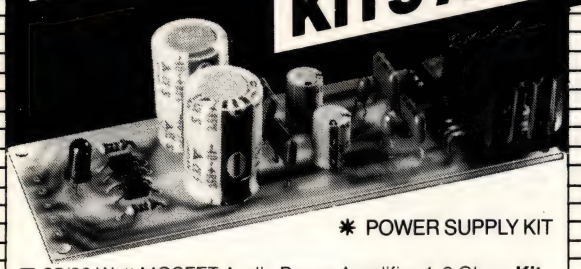
ZENITH ELECTRONICS

KITS AND



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BBC COMPLETES RDS

Following on from the pop picking radio report (see page 39), the BBC have told us that they are leading the way amongst European Broadcasters with the revolutionary Radio Data System.

Recently BBC engineers completed the installation, ahead of schedule, of RDS equipment at all of it's Network and Local Radio vhf-fm transmitters serving England. These RDS signals will allow an "intelligent" receiver to automatically tune to the best signal, give a visual indication of the station name, and display the current time and date.

The RDS data, which is currently statically configured, is carried on an inaudible 57kHz subcarrier on every vhf-fm transmitter serving England. It will be extended to Scotland, Wales and Northern Ireland in an installation programme beginning during 1988. The codes being transmitted conform to the European Broadcasting Union (EBU) specification, and consist of pi (programme information), ps (programme service), af (alternate frequency), on (other networks information), and ct (clock time and date).

The system will be dynamically configured from April 1988 when the RDS central computer, located in the Control Room at Broadcasting House, London, is put on-line. This will allow codes to be updated, for example when the Radio 2 vhf-fm transmitters are carrying Radio 1 programmes. It will allow a travel service using the ta (travel announcement) and tp (travel programme) codes, which will be added in the Autumn 1988. This potentially will be the most efficient travel information service ever offered, because in-car listeners with RDS radios will, at their choice, have their regular listening entertainment interrupted by local travel flashes from the relevant BBC county station whose area in which they are driving.

The RDS service will be publicly launched at the BBC Radio Show, being held at Earl's Court, London, from 30 September to 10th October 1988.

Ed.

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SPACEWATCH

BY DR PATRICK MOORE

OUR REGULAR LOOK AT ASTRONOMY

Russian astronaut Romanenko has returned in good health. Manned flight to Mars must be a step closer.

As I reported in last month's *Spacewatch*, the quasar distance-record has been broken yet again. The quasar Q0000-26, a 20th-magnitude object on the borders of Sculptor and Cetus – has a red shift of 4.11, corresponding to a distance of around 13,000 million lightyears and a recessional velocity 93 per cent that of light. Yet some uneasy doubts are starting to creep in. For years now Dr Halton C. Arp, formerly of Mount Wilson Observatory and now at the Max Planck Institute in Germany, has been maintaining that the red shifts are not pure Doppler effects, and are therefore unreliable as distance indicators. Arp has shown that in many cases, obviously-associated galaxies and quasars, or even pairs of galaxies, have completely different red shifts. In his new book *Quasars, Redshifts and Controversies*, Arp repeats these claims, and produces observational evidence in support. He is not alone in his views; one of his notable supporters is Fred Hoyle.

At the moment, the majority view is that the correlations are coincidental, and that the quasars really are super-luminous and so remote that they cannot be too far from the edge of the observable universe. But if Arp is correct, then quasars might even be found in our own Local Group of galaxies, and many of our cherished theories will have to be abandoned. We may not be back in Square One, but we will certainly have returned to Square Two! We must now await the results of further research.

There are reports that a meteorite – the Murray Meteorite, from Kentucky – has been found to contain specks of silicon carbide which are very old indeed: older than the Solar System. If this is confirmed, it will be of great cosmological importance, but again we must await further studies.

The Sky This Month

Venus still dominates the early evening sky throughout March this year. Its magnitude remains at –4.2, but it is not yet at its brightest; this will occur when the phase has decreased to less than half – the lesser distance from Earth more than compensating for the fact that less of the sunlit hemisphere is turned in our direction. In March the phase shrinks, theoretically, from 66 per cent to 53 per cent; but during evening apparitions the time of 'dichotomy' or exact half-phase is always early, and so observers will do well to estimate the phase during the last few evenings of March. This "Schröter effect" (a name which I introduced many years ago, because the phase discrepancy was first noted by the German pioneer observer J.H. Schröter) is due to Venus' dense atmosphere.

On March 6 Venus is only 2 degrees away from Jupiter, and this will be an event worth photographing even though it is not in the least important scientifically. Of the other naked-eye planets, Mercury will not be on view this month, but Saturn (magnitude +0.5) is a morning object, low down in the constellation of Sagittarius.

The Moon is full on March 3, and new on the 18th.

There is a total eclipse of the Sun on March 17/18, but unfortunately nothing of it will be seen from Britain; to see it you most go on a long journey – for example the Philippines, the Aleutian Islands, north-west Australia, New Guinea or western Hawaii. The maximum length of totality will be 3m 46s. For the next British total eclipse we must wait until 11 August 1999.

There are no major meteor showers in March, though we may see a few Virginids (the maximum of this shower is around 12 April, but at best it is very sparse). Neither are there any bright periodical comets on view.

In the starry sky, we have more or less completed the changeover from winter to spring groups. Orion sets in mid-evening, leaving only part of the Hunter's retinue on view – notably the Twins, Castor and Pollux, and the brilliant Capella in Auriga. Ursa Major, the Great Bear, is almost overhead; follow round the 'tail' and you will reach Arcturus in Boötes, the Herdsman, a lovely light orange star which is actually the brightest in the northern hemisphere of the sky (its only superiors – Sirius, Canopus and Alpha Centauri – are all south of the celestial equator). Note the little semicircle of stars close to Arcturus which marks Corona Borealis, the Northern Crown. In the 'bowl' of the Crown you can usually see two stars with any binoculars. One of these is of magnitude 6.6, not far below naked-eye visibility. The other is the famous variable R Coronæ, which is usually of magnitude 6, but which periodically 'viels' itself with clouds of soot and sinks to a minimum so faint that large telescopes are needed to show it at all. One can never tell when R Coronæ is going to fade, so it is worth keeping a check. It is not unique, but stars of the same type are very uncommon.

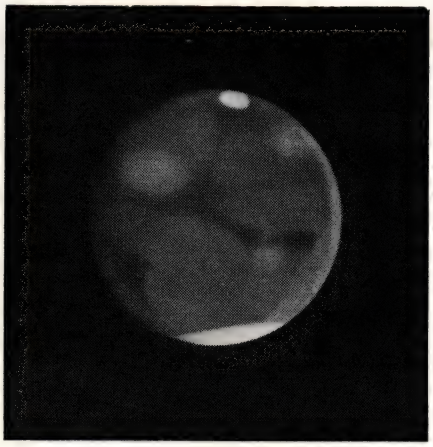
Leo, the Lion, is high in the south, and is the leader of the spring groups; it is marked by a curved line of stars, making up the so-called Sickle, of which the leader (Regulus) is of the first magnitude. The rest of Leo consists of a triangle of stars to the east of Leo. One of these, Denebola, was ranked of the first magnitude in ancient times, but is now rather below the second; either it has faded, or (more probably) there is some error in interpretation. Below Leo lies the vast, sprawling Hydra (the Watersnake). It is the largest constellation in the sky, but contains only one bright star – the reddish Alphard (the "Solitary One") which can be found by using Castor and Pollux as direction indicators.

THE WAY TO MARS?

On 29 December 1987 Colonel Yuri Romanenko, of the USSR, returned safely to Earth after having spent a record 326 days on the space-station Mir. Together with his fellow cosmonaut, Alexander Alexandrov, he came down in Soviet Kazkhstan, well on schedule. The two cosmonauts who have taken over on Mir – Vladimir Titov and Musa Manarov – expect to remain on the station for most or all of 1988.

It is an open secret that the Russians are thinking very seriously about a manned mission to Mars, and Romanenko is on record as saying that this long space mission has brought Mars 'closer'. It could well be that the Russians will reach for Mars without having landed a man on the Moon – though of course this is little more than guesswork. Meanwhile, what are the prospects for Mars?

Though the Soviet instrumentation is in many ways inferior to the American, there can be little doubt that on the whole they are now much more advanced in space – particularly in view of the new troubles with the US Shuttle. (How well I remember Wernher von Braun telling me that he would never willingly use solid fuels for launching a man into space!) So far as Mars is concerned there is every reason to suppose that the electronics techniques



are fully adequate. So, probably, is the guidance, though it must always be remembered that Mars is a very different proposition from the Moon; it is much further away, does not keep close beside us as we travel round the Sun, and provides no chances for a 'quick return', as happened with Apollo 13 when there was an explosion on board the space-craft during the outward journey. On the other hand, Mars does almost certainly have a supply of H_2O, locked up as ice, and the surface gravity is much greater than that of the Moon. The main problem is the fact that the thin, carbondioxide atmosphere is of very little use so far as men are concerned.

Were these the only hazards, there might be no reason why a Mars mission should not be feasible within the next decade or two – but there is another point to be borne in mind: the human body. Can a man (or, for that matter, a woman) endure long periods of zero gravity without suffering permanent harm?

The Russians have taken all possible precautions (exercise, for example), but there are some factors outside their control, and one of these is a possible deterioration in a cosmonaut's bone structure. This is certainly one reason why cosmonauts have been left on Mir for protracted periods. What effects there have been on Romanenko we do not know at the time when I write these words, though he seems to have felt reasonably fit when he landed, and mentally he was in perfect condition. It may well be that he will provide invaluable clues when his state of health is monitored over the next few months.

So – will we get to Mars? I believe we will, within the next half-century and probably well before. If we fail, however, it will be due to human physique – not to electronics! PE

The drawing of Mars was made by Paul Doherty and is from an article on observing the planets in the February 1988 issue of Astronomy Now.

Astronomy Now

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SEMICONDUCTORS

PART 5: POWER MOSFETS

BY ANDREW ARMSTRONG

CMos, VMos, DMos

The versatility of mosfets means that their range of applications is expanding faster than that of other discrete semiconductors, especially for small high frequency signals and large power-handling functions.

In part 4 we looked at some of the characteristics and applications of junction fets. Here we shall look at what I think is the most interesting area of discrete semiconductors, mosfets. This generic term covers a wide range of device types, including dual gate mosfets intended for use as small signal uhf amplifiers, and high power devices capable of switching tens of amps and/or hundreds of volts.

CASCODE

First of all, however, there is one more junction fet application to cover. The circuit configuration is cascode, and it has the advantage of leading on neatly to dual gate mosfets. Fig.47 shows an example of a cascode rf amplifier circuit. In this circuit, the input signal is isolated from the output signal because they use different fets. This means that the output signal cannot affect the input signal via the miller (drain to gate) capacitance of the fet.

Such signal feedback can reduce the gain at moderate frequencies, as well as reducing the apparent input impedance, but at vhf and uhf the phase shift in the fet and circuit can be enough for the miller feedback to cause oscillation. This effect can be tuned out by extra controlled feedback, at least over a limited frequency range. This technique, known as neutralisation, has been used both for valve and fet circuits, and is probably best known by radio amateurs who have built hf linear power amplifiers or two metre converters in times gone by.

More advanced two metre converters used a cascode circuit to avoid the problems of adjusting the neutralisation, and nowadays would almost always use a dual gate mosfet such as the BF981. Fig.48 shows an rf amplifier with an equivalent function to that of Fig.47, but using a BF981 dual gate mosfet.

In this circuit, you will notice that there are small value resistors in series with the decoupling capacitor on the second ground. The test circuits in semiconductor data books normally show a decoupling capacitor without a series resistor, but in practice, with a tuned load connected to the drain, the circuit is likely to oscillate. This effect is apparently a function of internal

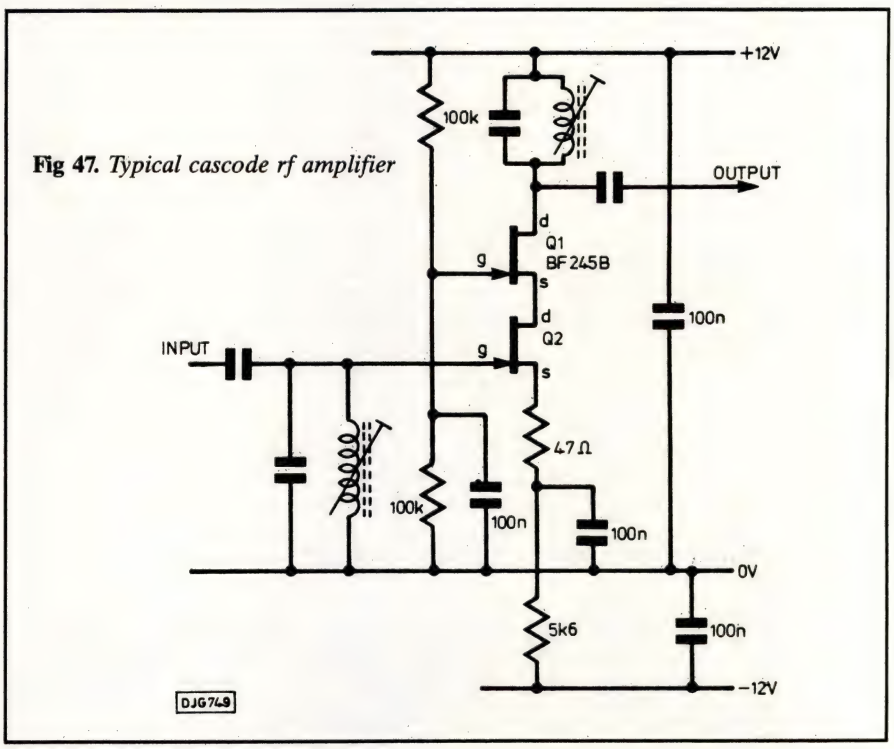


Fig 47. *Typical cascode rf amplifier*

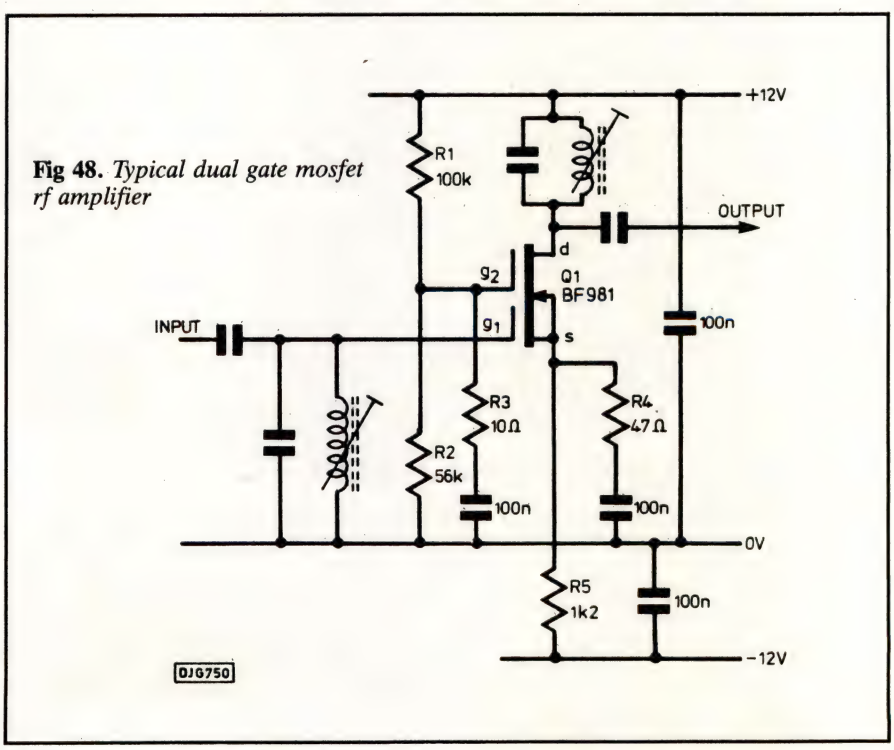
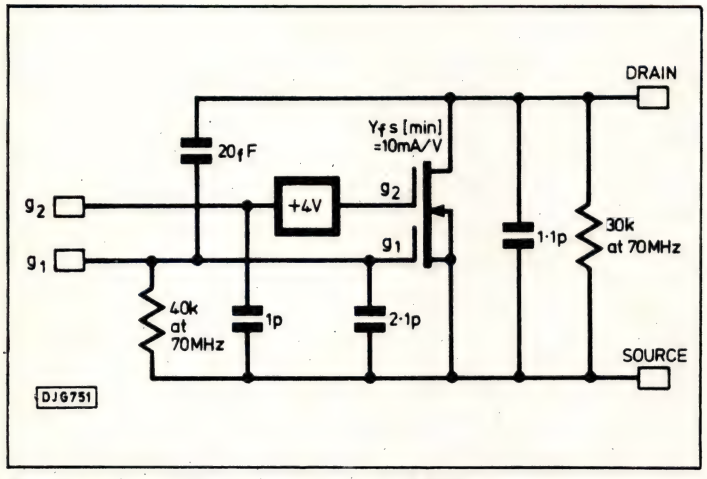


Fig 48. *Typical dual gate mosfet rf amplifier*



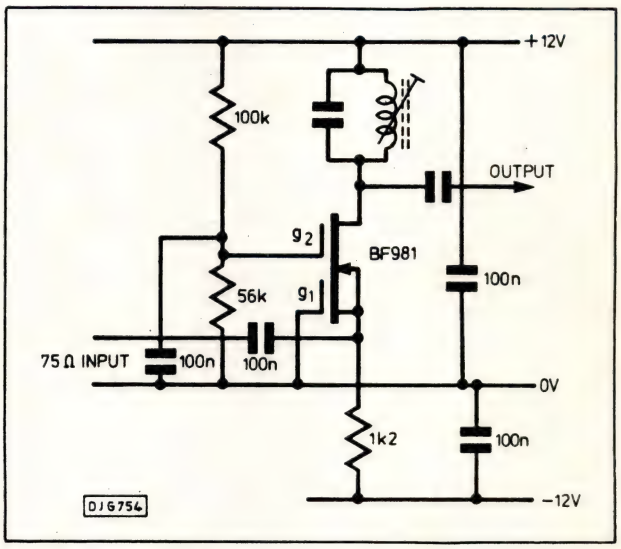


Fig 49. *(Above) Equivalent circuit to BF981*
Fig 52. *(Right) Low impedance source amplifying*

capacitances of the device causing an apparent negative resistance in series with gate two. This oscillates due to stray capacitance from the drain load unless the negative incremental resistance is cancelled by a positive resistance.

MULTIPLICATION

The second gate of the dual gate mosfet does not have to be decoupled to earth. The bias voltage applied to this gate controls the gain of the device, and the effect is approximately linear over a limited range. The obvious application of this effect is to carry out agc gain control in a radio receiver, and dual gate mosfets are used in just this way. Gain reduction by this method can prevent a strong signal from being amplified so much as to overload the next stage, but it cannot prevent overload of the stage being controlled. It is a useful technique, but cannot substitute for a switched attenuator in conditions of very high local signal.

Another slightly less obvious use for gate two is to inject local oscillator signal in the mixer stage of a radio receiver. This is slightly less obvious, but ideally a mixer should be linear with respect to the input signal and the local oscillator, so as not to generate harmonics and cause crossmodulation, noise modulation, and other problems. It should, however, multiply the two signals so as to produce sum and difference signals.

$$\sin(w1) \times \sin(w2) = \tfrac{1}{2} \times (\cos(w1-w2)-\cos(w1+w2))$$

in the ideal case.

The dynamic range is limited, so that this is not always suitable for the first mixer of a communications receiver, but for the second mixer (eg to convert 10.7 to 470 kHz) it is very useful.

CHARACTERISTICS

The BF981 is a particularly useful mosfet for amateur rf construction, so I have included more information on it. Fig.49 shows an approximate equivalent circuit for the device. The capacitances shown behave as you might expect, but the resistances are dependent on frequency, with an effectively infinite value at dc. The resistances, determined at a particular frequency from graphs showing input admittance and output impedance, are due to a combination of the limited operating frequency of the device and its internal stray feedback effects.

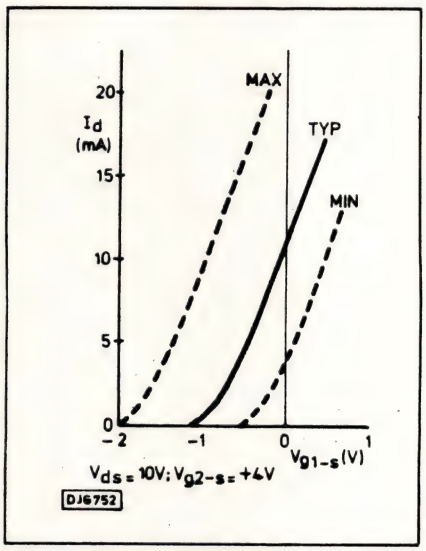


Fig 50. *Bias voltage against current*

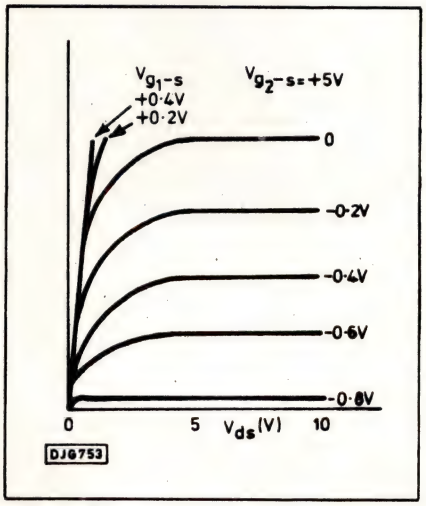


Fig 51. *Drain characteristics*

Further information for the would-be designer is given in Fig.50 and Fig.51, which show the mutual conductance curve and the drain characteristics respectively. As is clear from the graphs, this mosfet is a depletion mode device, which seems to be a characteristic common to most rf mosfets.

The curves in Fig.50 show that the bias voltage to produce any given current can vary from device to device by 1.2 volts, over which range the drain current changes by approximately 10mA. Clearly, a fixed bias voltage between gate and source would not be appropriate, and some means of stabilising the bias would be required. The circuit of Fig.48 demonstrates this. The voltage across R5 is approximately 12V, and fet bias voltage variations will change this by less than 10% from device to device.

Sometimes, for example to achieve the lowest possible noise figure in amplifying the signal from a low impedance source, it can be advantageous to feed the signal into the source terminal of the mosfet, as illustrated in Fig.52. In this case it is important to know the source impedance.

Forgetting any reactive effects, which are usually small, the resistance looking into the source is determined by how much the source current changes for a given change of source voltage, ie the Yfs figure in the data book. The Yfs is quoted as 10mA/V (min) and 14mA/V (typ). No maximum figure is given, but it would be safe to assume that few devices if any will exceed a gain of 20mA/V. 10mA/V corresponds to 100Ω, and 14mA/V to 71.4Ω so the source will provide a reasonable match to a 75Ω signal source.

POWER MOSFETS

To delve further into the intricacies of rf design using dual gate mosfets would

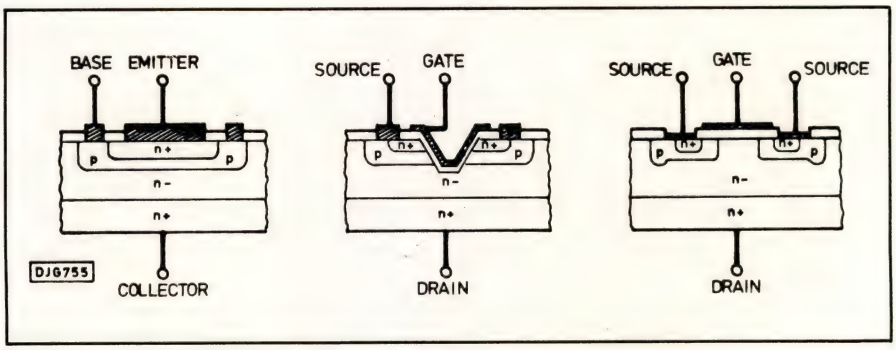
only be warranted in the design of a project, so now we will turn to look at power mosfets. For the purposes of this feature, I am defining power devices to include small mosfets such as the VN10, because these devices are often used in ways more concerned with power switching and control than signal amplification. They are, at any rate, in a very different category from dual gate mosfets for rf use.

Several different types of power mosfets are available, and are intended for different purposes. Fig.53 compares vmos and dmos device structure with a four layer bipolar transistor. As well as showing general device structure, this comparison shows that power mosfets include both an antiparallel drain-source diode and a parasitic bipolar transistor in their structure.

The diode is often a useful addition to the device, and its current and switching time is specified in some data sheets. The transistor, on the other hand, is completely unwanted. Under most circumstances it cannot be biased on, and in any event its gain is very low, but it can cause trouble in some switching circuits, where charge storage can cause an unwanted conduction path for a brief period. Normally, however, it can be ignored.

Both vmos and dmos devices have a relatively low gate capacitance and a correspondingly high on resistance. Producing devices with a lower on resistance almost inevitably results in higher capacitance. For example, the VN67 vmos fet has an input capacitance (Ciss) of 50pF, and a reverse transfer capacitance (Crss) of 10pF. Its R_{DS} (on) is $3\Omega\mu$. The IRFZ30 hexfet has a Ciss of 1600pF and a Crss of 200pF. It takes much more drive current to switch this latter fet quickly, but its R_{DS} (on) is 0.05Ω.

The structure of a hexfet is shown in Fig.54. The typical hexfet has a large array of hexagonal elements, with a correspondingly large gate area. Note the use of a polysilicon gate rather than the metalised type used in vmos fets. It would be more difficult to deposit a metal gate to the required accuracy than to diffuse a layer of silicon.



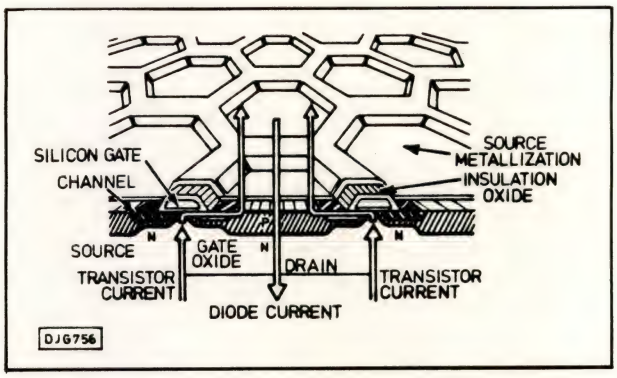


Fig 53. *(Above) Junction transistor, VMos and DMos comparison. L-R: 4-layer bipolar transistor, VMos fet, vertical DMos fet.*
Fig 54. *(Right) Hexfet structure.*

TABLE 4 FETS

Type No.	gfs(min) mS	Idss mA min	Idss mA max	Vgs(off)V min	Vgs(off)V max	Ciss pF	Crss pF	Channel	COMMENTS
junction fets									
2N3819	3	2	20	-.7	-6	8	4	n	Gen purpose
BF245B	3	6	15	-.25	-8	4	1.1	n	Tighter spec
2N3820	0.8	0.3			8	32		p	complement
MPF102	2	2	20	-0.5	-7.5	7	3	n	vhf/uhf mixers
BFW11	3	4	10		6	5	0.8	n	low noise
mosfets									
BF981	10	4	25		-2.5	2.1	30fF	n	Dual gate vhf
Power mosfets (enhancement)		Rds (on) Ohms	Id (on) A	Vgs (th) min	Vgs (th) max				
VN10LM	200	5	0.75	0.8	2.5	60	5	n	60V
VN67A	170	3.5	1.5	0.8	2.5	50	10	n	60V
ZVN0106A	250	4	0.32	0.8	2.4	75	25	n	60VE line
ZVP0106A	150	5	0.28	-1.5	-3.5	75	45	p	60Vline
IRF530	4000	0.18	14	2	4	800	150	n	100V
IRF830	2500	1.5	4.5	2	4	800	200	n	500V
IRF9530	2000	0.3	-12	-2	-4	700	200	p	100V
IRFZ30	9000	0.05	30	2	4	1600	200	n	50V

Key gfs = transconductance
Idss = zero gate voltage drain current
Vgs(off) = voltage at which drain current declines to leakage level
Ciss = input capacitance
Crss = reverse transfer capacitance
Rds(on) = fully saturated drain source on resistance
Id(on) maximum on drain current
Vgs(th) = conduction threshold (for enhancement device)
fF = femto farads
mS = milli siemens

OTHER POWER FETS

There are a couple of other sub-genres of power fets which are of interest. The first is typified by Ferranti's ZVN and ZVP range of devices. These devices have a vertical dmos structure, and are available in a range of packages from E-line to TO3. The E-line devices are suitable for such purposes as switching lamps and relays when driven from cmos, in situations when darlington transistors would otherwise be required. They can also be used effectively for small switched mode power supplies and voltage converters. The ZVN0106A, which is included in Table 4, is a good example of this type of mosfet.

A fairly new device (introduced in the last year) is the HEXsense current sensing power mosfet. In this device, a few of the cells have a separate source connection. Because they are on the same die, and have the same electrical characteristics and operating temperature, the current flowing in these cells is an accurate fraction of the total device current. This lower current can be measured with a much lower power dis-

sipation than by measuring the whole device current. A typical current sense ratio if 1:1500.

A major application of HEXsense devices is likely to be in switched mode power supplies, where the switch current must be monitored. The linearity is not good enough to provide the only source of feedback in audio amplifiers, but the devices should be ideal for servos in which there is an overall control loop.

POWER CHARACTERISTICS

One obvious application for power mosfets is in switched mode power supplies. In this application, mosfets have one major advantage over bipolar transistors, in that they can be connected in parallel to increase the overall current capability without the need for current sharing resistors. If two similar mosfets are connected in parallel and driven with adequate voltage to make them switch, then a reasonable overall current rating for the circuit is 80% of the sum of the ratings of the parallel devices. This applies to larger numbers of parallel devices, though statistically there will be a greater safety margin if the 80% figure is used with larger numbers.

The reason for this is quite simple. While bipolar transistor have a positive temperature coefficient of current, which is to say that collector current increases as temperature increases, fets operate in the reverse manner. The value of R_{DS} (on) increases with temperature, so that if one device in a parallel combination passes more than its share of the current it will warm up and its resistance will increase relative to the other fets in the circuit. Thus any imbalance of current is self limiting.

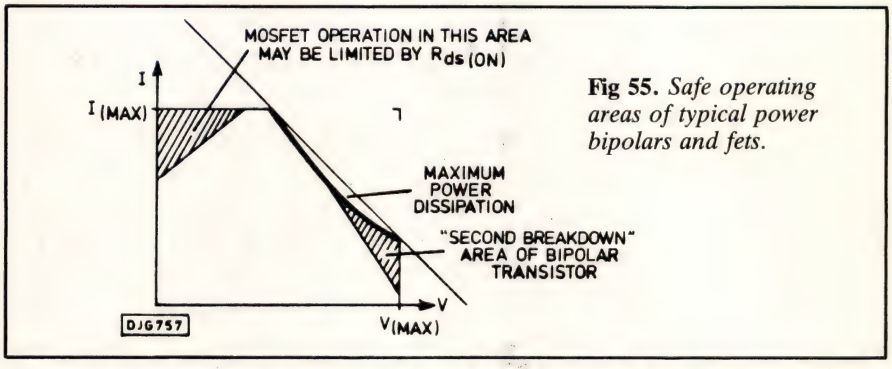


Fig 55. *Safe operating areas of typical power bipolars and fets.*

A factor which is helpful when designing power linear circuits is the absence of second breakdown in power mosfets. The operating conditions are limited by the maximum voltage rating at one extreme, the maximum current rating at the other, and otherwise only by power dissipation. This is illustrated by Fig.55, which compares the safe operating areas of typical power bipolar and field effect transistors.

To understand why power mosfets are better, imagine a large area power device (fet or bipolar) as a number of tiny devices in parallel. Bipolar transistors tend to share current unevenly, and destroy the highest gain device, while fets share current more evenly. The same effect occurs over the area of a large device, just sufficiently to generate hot spots in the collector bias junction which break down destructively at a lower voltage than the normal maximum voltage rating. When you think about it, it is surprising that second breakdown is not a worse problem than it actually is.

That concludes this episode in the semiconductor saga. Next month I intend to cover mosfet circuit applications, and may be able to include an audio power amplifier "mini project." There will also be a number of useful circuit building blocks. PE

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4585B	0.42
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40104	1.04
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40107	0.58
40108	2.97
40109	0.74
40110	1.95
40114	1.95
40116	13.87
40117	2.42
40147	2.74
40174	0.54
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40192	0.54
40193	0.54
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40374	1.10

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VP193	6	Sub Min. Electrolytics, 2 x 1000/2200/3300mf, 10/16v	£1.00

OPTOS

VP24	10	.125" clear lens showing Red LED's	£1.00
VP25	10	Mixed shape and colour LED's	£1.00
VP26	15	Small .125" Red LED's	£1.00
VP27	15	Large .2" Red LED's	£1.00
VP28	10	Rectangular .2" Red LED's	£1.00
VP57	25	Opto Special Pack. Assorted, super value	£3.00
VP130	6	RED 7 Seg. CC 14mm x 7.5mm RDP FND353 LED Display	£2.30
VP131	4	GREEN 7 Seg. CA.6" LDP XAN6520 LED Display	£2.00
VP133	6	RED Overflow .6" 3 x CA 3 x CC 6630/50 LED Display	£2.00
VP134	5	GREEN Overflow .6" CA XAN6530 LED Display	£2.00
VP138	20	Assorted LED Displays. Our mix, with data	£5.00
VP147	1	Pair Opto Coupled Modules	£0.60
VP199	4	LD707R LED Displays, CA	£1.00
VP203	15	Triangular shape LED's, mixed colours	£1.00
VP204	10	Large Green LED's, 5mm	£1.00
VP205	10	Small Green LED's 3mm	£1.00
VP206	10	Large Yellow LED's, 5mm	£1.00
VP207	10	Small Yellow LED's, 3mm	£1.00
VP208	10	Large LED's clear showing Red, .2"	£1.00
VP241	2	ORP12 Light Dependent Resistor	£1.50
VP242	3	Tri-colour LED's, 5mm dia., 5mA 2v, R.G.Y.	£1.00
VP243	3	Tri-colour LED'S, Rectangular 5mm,. R.G.Y.	£1.00
VP266	10	Orange LED's, 5mm large	£1.00
VP267	8	Stackable LED's. Rectangular, mixed, R.G.Y.	£1.00
VP268	15	LED Panel Mounting Clips, metal and plastic. 3-5mm	£1.00
VP269	2	Red Flashing LED's, 5mm	£1.00
VP284	2	Opto-Isolator IL74-4N27, single	£1.00
VP285	1	Dual Opton-Isolator ILD74	£1.00

DIODES & SCRS.

Pak No	Qty	Description	Price
VP29	30	Assorted volt Zeners. 50mw – 2w	£1.00
VP30	10	Assorted volt Zeners. 10w, coded	£1.00
VP31	10	5A SCR's TO66, 50 – 400v, coded	£1.00
VP32	20	3A SCR's TO66, up to 400v, uncoded	£1.00
VP33	100	Sil. Diodes like IN4148	£1.00
VP34	200	Sil. Diodes like OA200/BAX13-16, 40v 200mA	£1.00
VP35	50	1A IN4000 Diodes, all good, uncoded, 50v min	£1.00
VP49	30	Assorted Sil. Rectifiers 1A-10A, mixed volts	£1.00
VP141	40	IN4002 Sil. Rectifiers 1A 100v, preformed pitch	£1.00
VP142	4	40A Power Rectifiers, silicon, TO48 300 PIV	£1.00
VP143	5	BY187 12KV Sil. Diodes, in carriers, 2.5MA	£1.00
VP184	3	4A 400v Triacs, plastic	£1.00
VP187	10	SCR's 800MA, 200v, 2N5064, plastic, TO92	£1.00
VP194	50	OA91 point contact germanium Diodes, undcoded	£1.00
VP195	50	OA47 gold bonded germanium Diodes, uncoded	£1.00
VP196	50	OA70-79 detector germanium Diodes	£1.00
VP197	50	OA90 type germanium Diodes, uncoded	£1.00
VP198	40	BA248 Sil. Diodes, 350v 2A, fast recovery	£1.00
VP222	20	3A Stud Rectifiers, 50-400v, assorted	£1.00
VP274	12	SCR's (Thyristors) 1A 100-400v, TO-39	£1.00
VP275	3	5A 400v SCR's, TO220, TIC106D	£1.00
VP276	5	SCR's standard type, 5-16Amp to 400v	£1.00
VP277	4	Triacs 2Amp 400v TO-39	£1.00
VP278	4	6Amp 1000v plastic Silicon Rectifiers	£1.00
VP283	5	Diac BR100, triac trigger	£1.00

TRANSISTORS

VP38	100	Sil. Transistors, NPN plastic, coded, with data	£3.00
VP39	100	Sil. Transistors, PNP plastic, coded, with data	£3.00
VP47	10	Sil. Power Transistors, similiar 2N3055, uncoded	£1.00
VP48	5	Pairs NPN/PNP plastic Power Transistors, 4A, data	£1.00
VP50	60	NPN Sil. Switching Transistors, TO-18 and TO-92	£1.00
VP51	60	PNP Sil. Switching Transistors, TO-18 and To-92	£1.00
VP60	100	All sorts Transistors, NPN/PNP	£1.00
VP150	20	BC183B Sil. Transistors, NPN 30v 200mA Hfe240+ TO92	£1.00
VP151	25	BC171B Sil. Transistors, NPN 45v 100mA Hfe240+ TO92	£1.00
VP152	15	TIS90 Sil. Transistors, NPN 40v 400mA Hfe100+ TO92	£1.00
VP153	15	TIS91 Sil. Transistors, PNP 40v 400mA Hfe100+ TO92	£1.00
VP154	15	MPSA56 Sil. Transistors, PNP 80v 800mA Hfe50+ TO92	£1.00
VP155	20	BF595 Sil. Transistors, NPN eqvt BF184 H.F. TO92	£1.00
VP156	20	BF495 Sil. Transistors, NPN eqvt BF173 H.F. TO92	£1.00
VP157	15	ZTX500 series Sil. Transistors, PNP plastic	£1.00
VP158	15	ZTX107 Sil. Transistors, NPN eqvt BC107 plastic	£1.00
VP159	15	ZTX108 Sil. Transistors, NPN eqvt BC108 plastic	£1.00
VP161	25	BC183L Sil. Transistors, NPN 30v 200mA TO92	£1.00
VP162	5	SJE5451 Sil. Power Transistors, NPN 80v 4A Hfe20+	£1.00
VP163	2	NPN/PNP pairs Sil. Power Transistors, like SJE5451	£1.00
VP164	4	2N6289 Sil. Power Transistors, NPN 40v 40w 7A Hfe30+	£1.00
VP165	6	BFT33 NPN Sil. Transistors, 80v 5A Hfe50-200 TO39	£1.00
VP166	5	BFT34 NPN Sil. Transistors, 100v 5A Hfe50-200 TO39	£1.00
VP167	1	BUY69C NPN Transistors, TO3 VCB 500, 10A, 100w, Hfe15+	£1.00
VP168	10	BC478 eqvt BCY71 PNP Sil. Transistors. TO18	£1.00
VP169	10	BXS21 eqvt BC394 NPN Sil. Transistors, 80v 50mA TO18	£1.00
VP170	10	Assorted Power Transistors, NPN/PNP coded and data	£1.00
VP171	10	BF355 NPN TO-39 Sil. Transistor, eqvt BF258 225v 100mA	£1.00

TRANSISTORS

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VP172	10	SM1502 PNP TO-39 Sil. Transistors, 100v 100mA Hfe100+	£1.00
VP200	30	OC71 type germanium AF Transistors, uncoded	£1.00
VP201	25	OC45 germanium RF Transistors	£1.00
VP261	4	Programmable Unijunction Transistors, MEU22	£1.00
VP270	10	FET's UHF/VHF Amplifiers, switching & choppers, data	£1.00
VP271	10	FET's general purpose like 2N3819-2N5457, data	£1.00
VP272	10	MOS-FET's Signetics, SD304	£1.00
VP280	12	ZTX300 NPN Silicon Transistors	£1.00
VP290	15	MPSA06 Sil. Transistors. NPN 80v 500mA HFE50+ TO92	£1.00
VP428	10	AC128K PNP Germanium Transistor, 1A 32v	£1.00
VP429	10	AC176K NPN Germanium Transistor, 1A 32v	£1.00
VP430	4	2N3055 Sil. Power Transistors, full spec	£2.00
VP431	25	PNP Sil. Transistors, TO-39 like 2N2905A	£1.00

I.C.S.

VP40	40	TTL I.C.S. all new gates – Flip Flop – MSI, data	£4.00
VP54	20	Assorted I.C. DIL Sockets, 8 – 40 pin	£2.50
VP59	20	Assorted I.C.s linear, etc, all coded	£2.00
VP209	12	74LS00	£2.00
VP210	12	74S74	£2.00
VP2111	10	CD4001B	£2.00
VP212	10	CD4011B	£2.00
VP214	10	CD4069B	£2.00
VP215	10	741P 8 pin	£2.00
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VP42	10	Black Heatsinks, fit TO3 and TO220, drilled	£1.00
VP43	4	Power-fin Heatsinks, 2 x TO3, 2 x TO66	£1.00
VP44	15	Assorted Heatsinks, TO1/3/5/18/220	£1.00
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VP83	1	Electronic Buzzer, 6v, 25MA	£0.95
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VP85	1	Electronic Buzzer, 12v, 25MA	£0.95
VP86	1	TECASBOTY Components Pack, semiconductors, caps, wire, etc	£8.00
VP87	1	Telephone Pick-up Coil with 3.5mm jack plug	£1.25
VP88	1	Pillow Speaker with 3.5mm jack plug	£1.45
VP107	1	Piezo Buzzer, miniature, 12v	£1.25
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VP113	1	Coax Antenna Switch, 2 way	£4.50
VP114	1	Coax Antenna Switch, 3 way	£4.75
VP115	1	High Pass Filter/Suppressor, CB/TV	£0.50
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VP178	5	Assorted Battery Holders and Clips, PP3/9, AA/D, etc	£1.00
VP223A	6	Tag Boards, 18 way paxaline	£1.00
VP225	20	DIN Plugs, plastic 2-8 pin, 180°/240°/360° mixed	£2.50
VP226	20	DIN Chassis Skts, metal 2-8 pin 280°/240°/360° mixed	£2.50
VP227	18	DIN In-line Skts, plastic 2-8 pin 180°/240°/360° mixed	£2.50
VP228	10	C15 Computer Cassette Tapes. Leadless	£3.00
VP232	1	Cassette Head Cleaner/Demagnetizer, in case	£2.00
VP233	1	Revolving Cassette Rack, holds 32, smokey perspex	£2.50
VP244	1	High Power Piezo Electric Siren. Emits earpiecing warbling sound. Ideal alarm. White plastic body with mounting bracket. Power 12vDC 150mA. Output 100db (A) at 1m typ. freq. 2.5KHZ. Size: 57 x 42 x 37mm.	£6.00
VP260	1	9" x 6" Elliptical 8 ohms 10W RMS Speaker. Freq. Res 60-10000 Hz. Gauss 10000. Centre HF cone	£4.50
VP260A	1	2¼" Transducer Waterproof Speaker. Polyester film diaphragm. Moisture res. 8 ohms 300mW Freq. Res. 20-20000 Hz	£1.00
VP273	10	10K Lin Rotary Potentiometers, slim spindle	£1.00
VP281	4	Plug-in Relays. Mixed volts, etc.	£1.00

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VP95	1	Plastic Vice, small, with suction base	£1.75
VP97	1	Logic Probe/Tester, supply 4.5v – 18v, DTL, TTL, CMOS	£8.50
VP99	1	Universal Tester, with ceramic buzzer	£5.00
VP103	1	6 Pc STANLEY Screwdriver Set. Flat and crosspoint	£3.50
VP139	1	Pick-up Tool, spring load	£1.75
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VP250	1	Long Finger Grip. soldering aid. Heavy metal base. Serrated jaws with rev. tweezer action. Ideal for holding small components. Fully adjustable	£3.00
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VP414	1	End Action Stripping Pliers. Adjustable jaws	£1.00
VP415	1	5" Grip Locking Pliers	£3.00
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VP419	2	"Chubby" Screwdrivers. Crosspoint No 1 and 2	£1.50
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VP421	1	Screwdriver 400mm long, 6mm flat blade	£3.00
VP422	1	Screwdriver 400mm long, No 2 crosspoint	£3.00
VP423	1	Vernier Caliper-Crosshorns. Depth gauge. Vernier Cap. 4½"/110mm reading 1/128", 1/10mm	£2.50
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VP425	1	7 Pc high quality Screwdriver Set.	£8.50
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VP301	1	2m Video Lead Coaxial Skt to Coaxial Skt + 2 adaptors	£1.20
VP302	1	3m 4 core cable indv. screened 5 pin DIN Plug 5 pin DIN Plug	£1.80
VP303	1	TV Ext. Lead. Coax plug to Coax Plug. White	£1.00
VP304	1	1.5m 4 core indv. screen. 5 pin DIN Plug – tinned open end	£1.00
VP305	1	1.5m cable 5 pin DIN Plu-3.5mm Jack Plug. Pin 1 & 4 connect	£1.00
VP306	1	2m Typewriter/Calculator Lead. 3 pin Plug, angled European IEC configuration. 6A 250vAC	£2.00
VP307	1	60cm Patch Lead. PL259 Plug to PL259 Plug	£1.00
VP308	1	1.2m Patch Lead. PL259 Plug to PL259 Plug	£1.50
VP309	1	1.2m Lead 4 Phono Plugs to 4 Phono Plugs	£1.50
VP310	1	20cm Lead 2 x 2 pin DIN Plug to Stereo Inline Jack Skt	£1.00
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VP312	1	1.2m Video Lead. BNC Plug to Phono Plug	£1.50
VP313	1	3m Headphone Lead. 3.5mm Jack Plug to 3.5mm Jack Skt	£1.00
VP314	1	2m Coax Lead BNC Plug to BNC Plug. 75 ohms	£3.00
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VP316	1	5m Telephone Ext. Lead. Plug to Socket	£4.50
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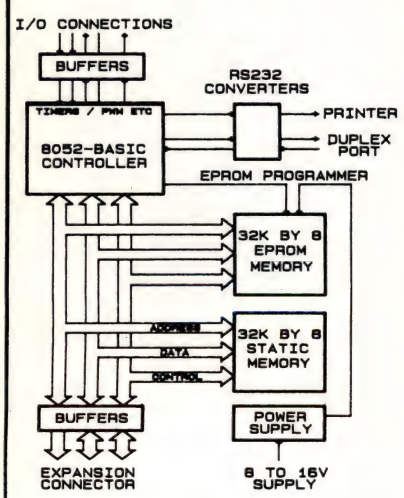

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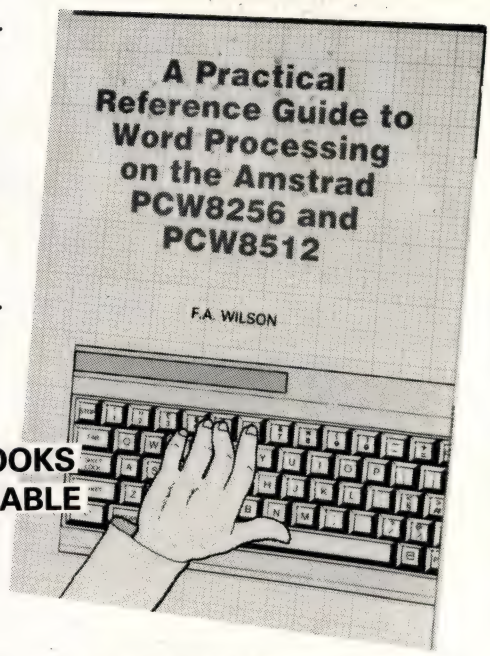

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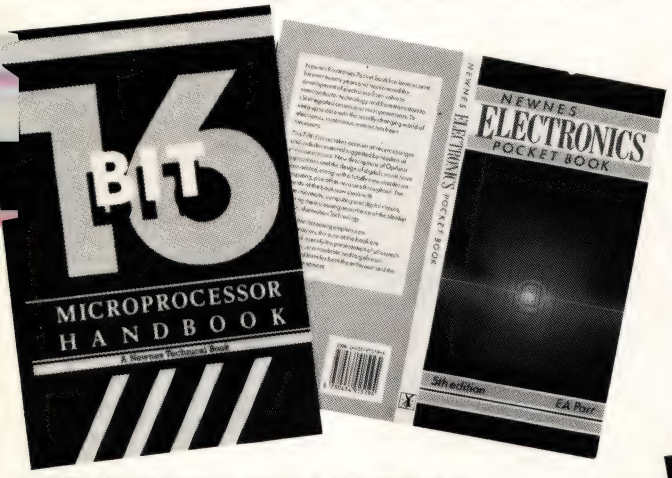

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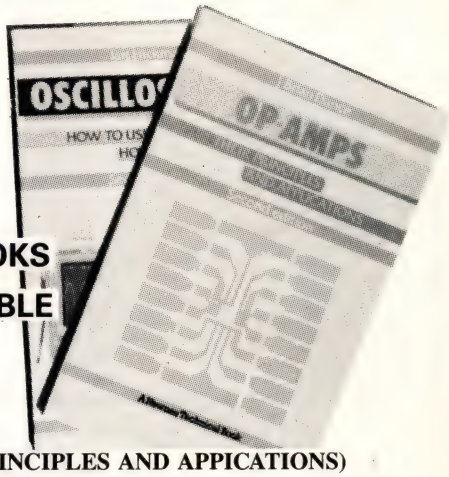

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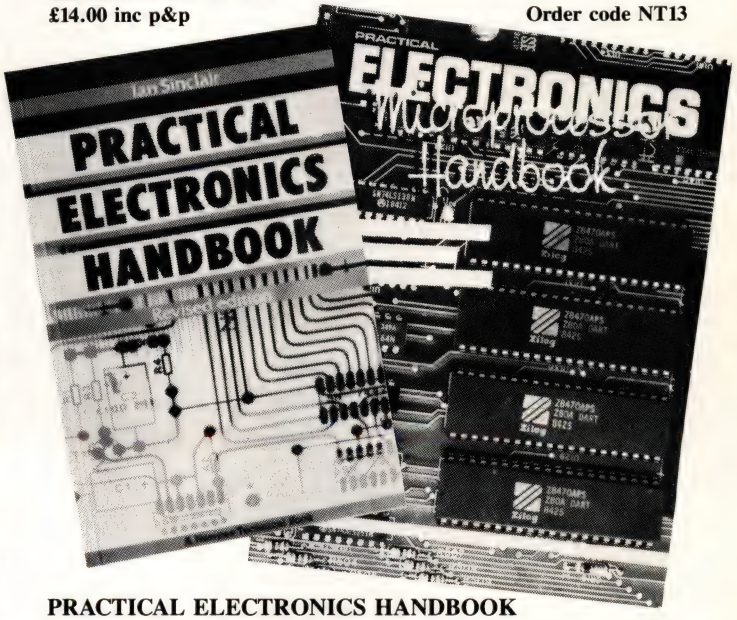

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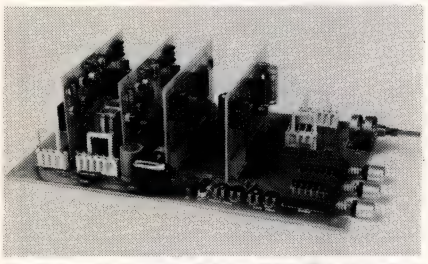

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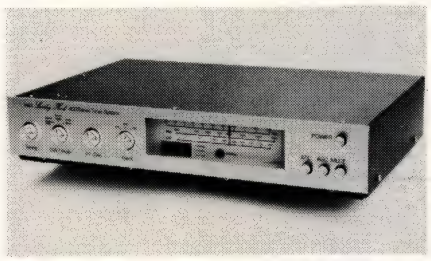

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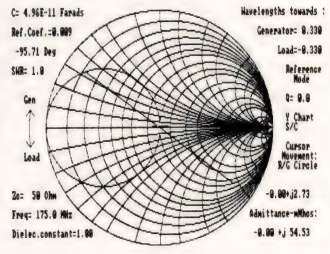

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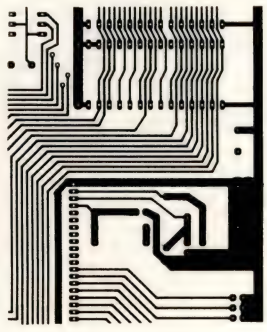

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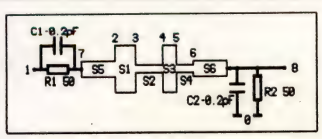

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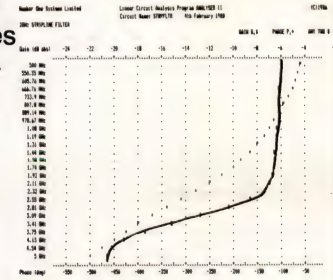

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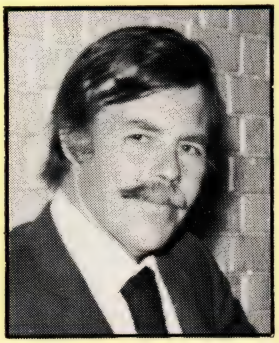

INDUSTRY NOTEBOOK

TWENTY-YEAR SHAKE-OUT

The retreat of the UK semiconductor industry, now regarded virtually as mythical, is only part of a worldwide concentration of manufacturing control.

REPORT BY TOM IVALL

When Ferranti sold its semiconductor business to Plessy a few months ago we witnessed the last stage in the rise and fall of the British-owned integrated circuits industry. Let's hope that Plessey makes a success of the new merged business. It stands a good chance of doing so, for it has now become the largest manufacturer of application-specific ics in Europe. And the market experts are predicting a world growth of about 25% per annum in this part of the semiconductor industry over the next few years.

But Plessey also finds itself virtually the last bastion of Britain's presence in the world chip-making scene. As such it has become a cynosure. All national hopes are pinned on it. At the same time this very fact shows that the company has had great strength to survive so long in this highly competitive field. It has made the right technical and commercial decisions – particularly to stay out of the cut-throat business of manufacturing standard devices for high-volume production.

Twenty years ago there were five British-owned ic manufacturers operating in the UK: Ferranti, Marconi, Plessey, AEI and Welwyn (in rough order of production volume). Subsequently AEI merged with GEC and semiconductor manufacturing was carried on by the last-named. GEC also had a one-third stake in a European joint-venture company called Associated Semiconductor Manufacturers, the other two-thirds being owned by Mullard, the Dutch Philips subsidiary.

But already in 1968 the big American companies like Texas, Motorola and SGS-Fairchild, assisted by a number of small suppliers like RCA, Sylvania and Transitron, had secured about 70% of the UK market for ics. And this was even before Intel had appeared on the scene with the first microprocessors and before the great commercial onslaught of the Japanese semiconductor firms.

So throughout the 1970s the British-owned ic companies were increasingly on the defensive. Their market share continued to shrink. At this point the rapid development of microprocessors and their associated semiconductor memories placed vlsi firmly in the centre of the electronics stage. The then Labour government feared that the UK would be elbowed out of vlsi chip-making altogether, and, in the absence of private capital, decided to invest public money in a nationally owned enterprise for large-volume manufacture of standard vlsi devices. Thus Inmos was born.

You may have thought I had forgotten Inmos in my preamble about Plessey now being the last bastion of the UK chip industry. It's true that Inmos is still (at the time of writing) a British-owned company. But there is now even more doubt about its future than when I reported on its situation in October 1986.

Although the Transputer family of products has been quite successful, taking about 5% of the world market for 32-bit microprocessors, the overall commercial progress of the company has been downhill all the way. In 1984 the UK government (by then Conservative) sold its majority shareholding to Thorn-EMI, but the new owners failed to turn the business round into steady profitability. Exposure to the supposedly healthy atmosphere of private enterprise was not in itself enough. Inmos is now losing about £95 million a year.

In my October 1986 report I mentioned that Inmos was cutting costs by pulling out of the highly competitive dynamic ram business, running down the Colorado Springs plant in the USA and shedding 670 jobs in the process. Now the contraction has been taken a stage further. Static rams have gone too, having also proved unprofitable, and the Colorado Springs factory has been completely shut down, with a further loss of 300 jobs.

It's no secret that Thorn-EMI wants to sell Inmos. The cost cutting exercises on memories and the resulting concentration on the Transputer products (which now account for over 50% of the chip-maker's revenue) are restructuring moves designed to make Inmos a more attractive package for potential buyers.

During 1987 Plessey was being discussed as possible purchaser, but while Inmos was still making standard chips the Plessey management declared it was definitely not interested. Will the present changed structure of Inmos make any difference? We can only wait and see. But if Plessey does not acquire Inmos, this once bright hope of state enterprise will probably fall into foreign hands. If a Japanese, American or European company did buy Inmos and made a big success out of the Transputer, as seems possible, we could only hope that certain decision-makers in Britain would have the moral decency to kick themselves really hard.

Ferranti's decision to sell off its semiconductor business to Plessey (for £30 million) is not hard to understand. Over two decades or more it made valiant efforts to establish itself as a viable chip-maker and, while doing so, introduced some technically advanced and useful products, such as the uncommitted logic array. But in the end the world competition proved too much.

The 1986/87 trading year was particularly bad because of very difficult conditions in the USA. Turnover was £66 million, but operating profit fell dramatically from the £3.7 million of the previous year to a mere tenth of that figure. The Ferranti management said during 1987 that it saw little prospect of an improvement, so the announcement of the sale to Plessey was not entirely a surprise.

All this contraction in the indigenous British semiconductor industry may seem a terrible tale of woe. But the process is by no means peculiar to the UK. In February of last year, for example, I reported that US companies were getting out of semiconductor memories. More recently the Italian firm SGS has merged with the semiconductor business of Thomson of France. Siemens and Philips have been defensively pooling some of their resources. In America again, the two giants General Electric and IBM have recently got together to develop application-specific ics. By the end of this decade the world semiconductor market could well be dominated by a mere half-a-dozen multinational companies. PE

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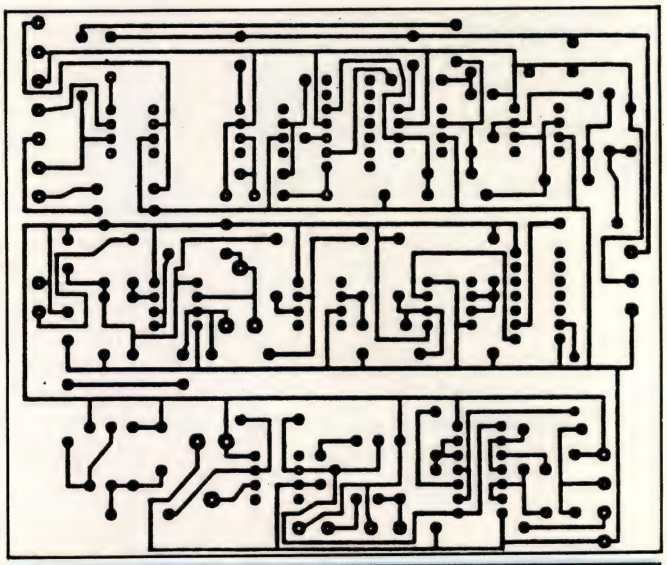

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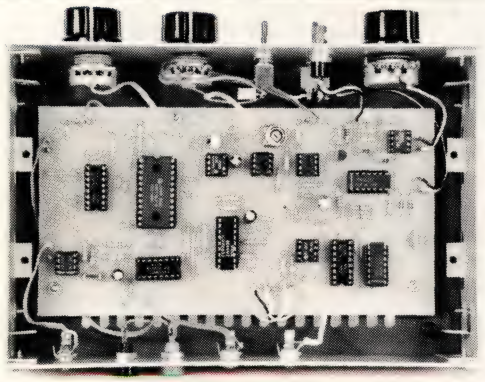

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IDENTITIES

Component identities are usually clearly marked on them. Even if they are colour coded, like some resistors and capacitors, their values are easily worked out from component colour code charts. From time to time we publish these charts, but if you don't already have one, send a 9in x 4in stamped and self-addressed envelope to the Editorial office asking for one.

TOOLS

For many projects you only need a few simple tools – Soldering iron between 15W and 25W, with a bevelled tip. Damp sponge for keeping the tip clean. Good multicore solder of 18swg or 22swg grade. Fine nose pliers for wire shaping. Adjustable spanner or heavy pliers for tightening nuts. Miniature screwdriver for adjusting preset controls. Small wire cutters for trimming component leads. Drill and selection of bits for drilling holes in boxes. Strong magnifying glass for checking joins in close up. It's also preferable to have a multimeter for setting and checking voltages. There are some very good low cost ones available through many of our advertisers, but get one that is rated at a minimum of 20,000 ohms per volt. Many projects do not require you to have a meter, but if you are serious about electronics, you really should have one.

ASSEMBLING THE PCB

Authors will sometimes offer their own advice on the order of assembly, but as a general guide, it is usually easier to assemble parts in order of size. Start though with the integrated circuit sockets. Please use them where possible, they make life much easier than if you solder the ICs themselves – with sockets you can just lift out an IC if you want.

Then insert and solder in order of resistors, diodes, presets, small capacitors, other capacitors, and finally transistors. Clip off the excess component leads after you have soldered them. Now use a magnifying glass, ideally one that you can hold to your eye, and take a good look at the joins, checking that they are satisfactorily soldered, and that no solder has spread between the PCB tracks and other joins. Be really thorough with visual checking since errors like this are the most likely reason for a circuit not working first time.

SOLDERING

Bring the tip of the iron into contact with the component lead and the PCB solder pad, then bring the end of the solder into contact with all three, feeding it in as it melts. Once sufficient solder has melted to fully surround the pad and the lead, remove the solder, and then the iron. Now allow the join to cool before touching it, otherwise the solder may set unsatisfactorily. If it does move, just reheat the join once more.

WIRING

Connecting the PCB to the various panel controls is the final assembly stage. Do this just as methodically, following the published wiring diagram. You can connect the wires to the PCB in one of three ways. The best is to insert terminal pins into the connecting holes on the PCB, and then solder wires direct to them. Or, pass the end of the wire through the PCB hole, soldering it on the other side. Alternatively, the wire can be carefully soldered direct to the PCB tracking. In all cases first strip the plastic covering off the wire, twist the strands together, and apply solder to them to keep them secure.

TESTING

Now you are ready to test and use the project as described by the author. Components can occasionally fail, but these days it is extremely uncommon, and if you have followed the instructions, been careful with your joins, and bought the parts from a good supplier, you will have the enormous satisfaction of having built an interesting and working unit. It really can be easy if you do it with care.

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Some projects are available from advertising suppliers as complete kits. Where this is so, the source often will have been stated in the project text. If no supplier is quoted, contact the normal kit suppliers anyway – they might well have introduced a kit after publication. Otherwise, all the components listed in the text will be available from suppliers who specialise in individual components.

Occasionally a specific part may only be available from a particular supplier, if so the source will be given in the parts list. Otherwise there should be no difficulty in buying the parts. We have many good suppliers advertising in PE so have a look through their adverts – that's why they're there! Even though a part may not be listed in the adverts, a phone call or two should find a supplier who will be pleased to help. Like us, they too are in the business of encouraging you to enjoy electronics! PE

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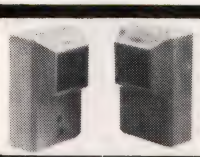

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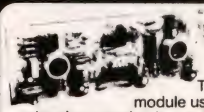

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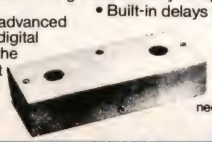

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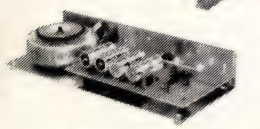
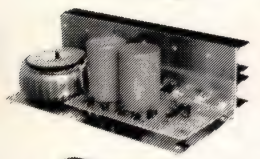
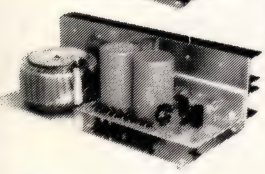


OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. —125dB. Size 300 × 123 × 60mm. PRICE **PRICE £39.99 + £3.00 P&P.**

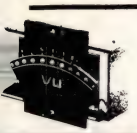


OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 250, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. —130dB. Size 300 × 150 × 100mm. PRICE **PRICE £62.99 + £3.50 P&P.**



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz —3dB, Damping Factor 350, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. —130dB, Size 330 × 147 × 102mm. PRICE **PRICE £79.99 + £4.50 P&P.**

NOTE: Mos-Fets are supplied as standard (100KHz bandwidth & Input Sensitivity 500mV) If required, P.A. version (50KHz bandwidth & Input Sensitivity 775mV) Order — Standard or P.A.



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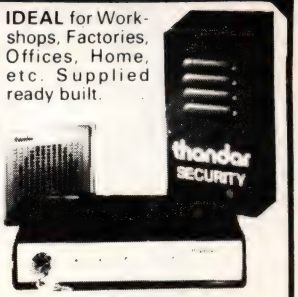

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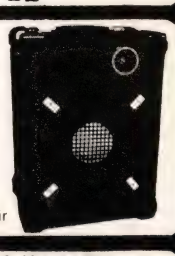

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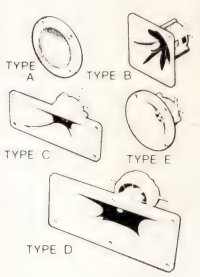

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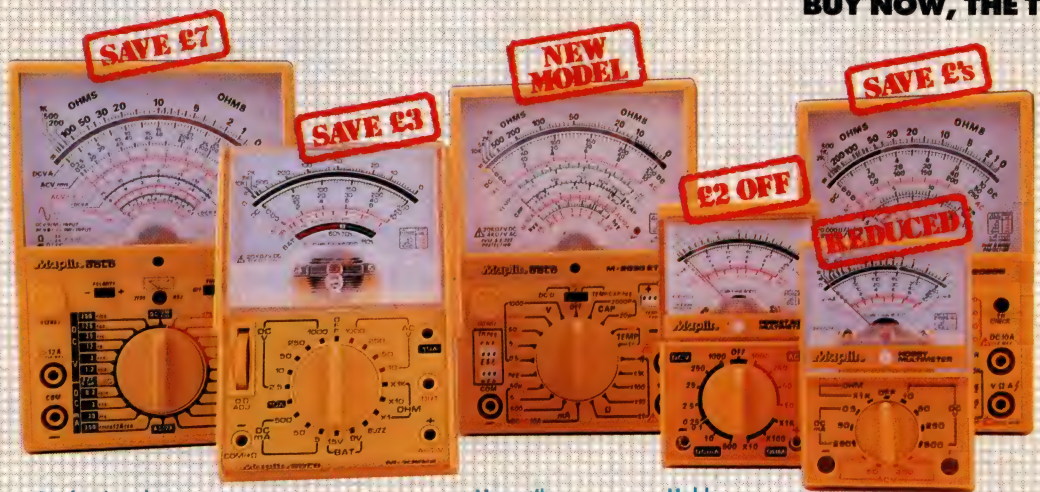

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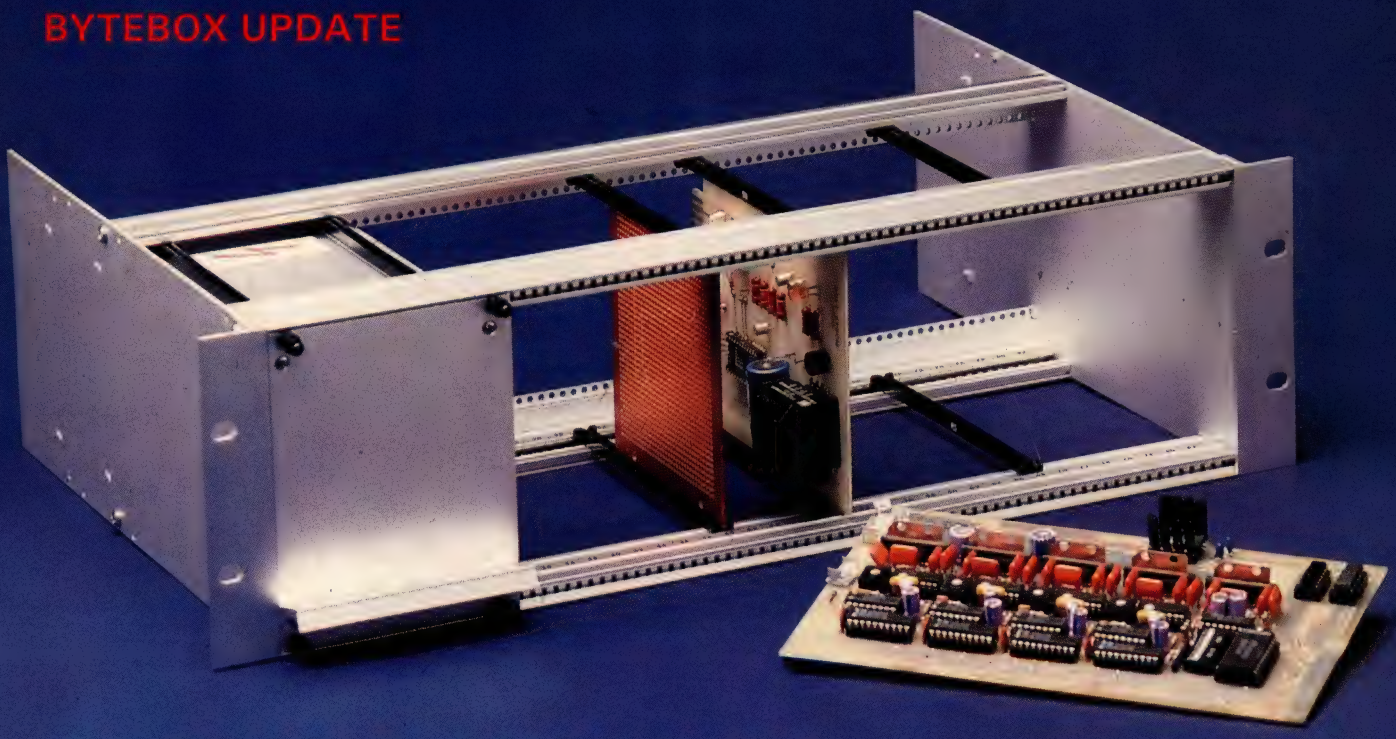

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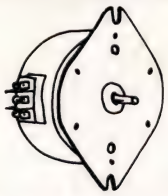

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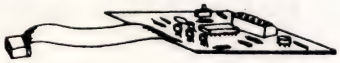

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MOTOR — GEARBOX ASSEMBLIES 1.5V-4.5V.
Miniature precision made. Complete with quality electric motors. Variable reduction ratios. Long 3mm dia output shafts.
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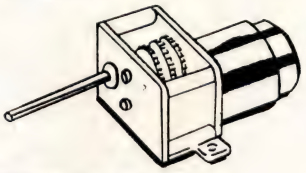

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SMALL TYPE 187 **£9.85**
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BBC HEART RATE

BBC Heart Rate Monitor— Ready Built £35.99

Practise relaxation or monitor fitness with this plug-in heart rate monitor. Connects directly to the BBC computer. Programs give continuous heart rate displays, bar charts, graphs etc. Supplied with sensor, software & instructions — ready to plug in and use.

fischertechnik

We offer a range of the superb Fischertechnik sets. These cover robotics, electronics, electromechanics, motors and gears, and basic construction.
Robotics kit builds 11 different working models including a robot arm, graphics board, sorting system etc. Note that not all the models can be built at the same time. Simple to assemble. Easily combined with all other Fischertechnik kits. Top quality. Includes 2 motors, an electromagnet, lamps, potentiometers, switches etc.
ROBOTICS Kit (554) PE **£68.99**
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Use ut2 to motorise ut1
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Electronics (ut4) **£93.90**

BBC — ROBOTICS INTERFACE

A READY TO USE INTERFACE for the BBC computer and the Fischertechnik Computing and Robotics Kit (554).
Allows the BBC computer to operate all 11 of the standard models which can be built from the Fischertechnik Robotics kit.
The interface features forward, reverse and on/off control of four DC motors; on/off control output for driving an electromagnet or similar device; and eight switch inputs for reading microswitches or other binary inputs.
Two independent analogue input channels are provided for position sensing.
Supplied complete with connectors and leads the interface requires a power source of 9–12 volts at 1A.
Detailed programming information is supplied with the interface. A software disc with a comprehensive set of programs is also included.
FISCHERTECHNIK ROBOTICS — BBC COMPUTER INTERFACE (BUILT) (PE) **£69.95**

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AND SINGLE BOARD COMPUTER

A new single board training and evaluation system for the 16-bit 68000 Series Microprocessor. A standard working system in kit form costs just **£99.00 including VAT.** Programs are developed and written with the aid of an on-board monitor program. The system is programmed and run via an RS232 link from either a standard terminal or a BBC Computer programmed to act as a terminal (we can supply the necessary software). Optional extras include a line by line assembler, a peripheral I/O port and timer, and a G64 bus interface. Full sets of technical literature, programming information and manufacturers' data sheets are available to accompany the system.

AVAILABLE FROM STOCK NOW
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A stand-alone unit with hexadecimal keyboard and 9-digit seven-segment display. Uses a control oriented 68705 microprocessor with a comprehensive monitor system. A bank of 8 LEDs and switches allows I/O control programs to be run before connecting to 'real' external circuits. An A/D–D/A board is also available along with full support literature. An excellent introduction to machine code programming right down to 'bit' level. Used in many educational establishments. A complete system costs under £50.
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CATALOGUE

Brief details of each kit, book contents, and illustrations and descriptions of our range of tools and components are all included.
Robotics and Computing section included.
Our advert shows just a selection of our products.
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We regret that lengthy technical enquiries cannot be answered over the telephone

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A useful audio add-on incorporating a CCD delay line

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An IEEE1000 compatible PSU with additional features such as variable output for EPROM programming

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OUR MAY 1986 ISSUE WILL BE ON SALE FRIDAY, APRIL 4th, 1986 ***(see page 37)***

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WHAT'S NEW...

Surfboards Aid Surface-mount Prototyping

Global Specialties has introduced a completely new concept for building prototype circuits using surface-mount chips.

With Global's Surfboard the designer places a plastic leaded chip carrier (PLCC) into a chip carrier socket and has instant breadboarding access to the electronics in the chip, without soldering or permanent connections.

The Surfboard provides a numbered breadboarding tie-point for each lead on a chip carrier. Connection of a particular lead is achieved by inserting standard 22-gauge hook-up wire into the corresponding tie-point.

The Surfboard chip carrier socket is fabricated in phosphor bronze with tin-plated contacts. It accepts a JEDEC type A PLCC and is polarised for easy registration. Stand-offs are provided for heat dissipation.

The breadboard has replaceable nickel silver contacts and accepts components which have up to 0·033 in. leads. Three Surfboard models are available which accommodate 44, 68 and 84-pin PLCCs.

Details from: Global Specialties Corporation (UK) Ltd, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

Intelligent Digital Multimeter

The new intelligent multimeter from M.S. Components features a wide range of computing and automatic data storage functions.

Microprocessor-controlled, it displays both direct readings and computed functions on a clear 5½-digit l.e.d. display with a resolution of ± 1μV or 1nA. A total of 28 ranges are available.

Computed functions are keyed in via a built-in keypad and include ground reference shift, percentage deviation, limit comparison and many other functions. An integral logging memory, with programmable timing, has a capacity of 100 readings and an optional RS232 serial interface is available for data output.

Details from: M.S. Components Ltd, Zephyr House, Waring Street, West Norwood, London SE27 9LH.

Digital R.C.C.B. Trip Tester

TMK announce the availability of model TEM 1400B, a new digital R.C.C.B. Trip Tester complying with the 15th Edition of the IEE Wiring Regulations. TEM 1400B is designed to make quick, safe and accurate measurements of the trip time of residual current circuit breakers at various required levels of fault current, a test that has become increasingly important.

This new 3½ digit l.c.d. instrument is easy to operate, hand held and battery operated, with bright l.e.d. indication of P–E and P–N. Trip times are measured from 0 to 200ms with a 1ms resolution to a ± 5msec accuracy and trip times can be held for up to 40s until the push button is released.

The TMK, TEM 1400B is compact, rugged, reliable and is fully guaranteed, measures 142 × 62 × 34mm, weighs approx. 250gms and comes complete with a mains test lead, battery, operating instructions and carrying case.

Details from: Harris Electronics (London), 138 Grays Inn Road, London WC1X 8AX.

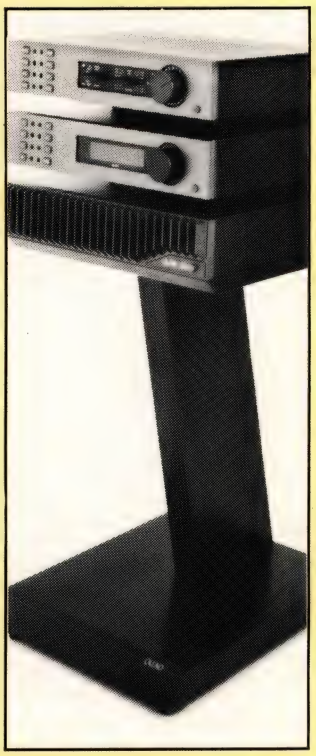
Quad 306 Power Amplifier

QUAD, in the guise of the Acoustical Manufacturing Company, was founded in 1936. It is fitting that their first news in their 50th anniversary year, is the announcement of a new power amplifier.

The QUAD 306 is designed to provide the most accurate and realistic music production in high quality domestic systems. Power output is more than adequate for the vast majority of systems (70 watts into 8 ohms on music programme).

The QUAD 306 uses a refined and developed version of the feed forward error correction circuit which QUAD patented in 1975 and nicknamed "Current Dumping". Some of the more obvious features of the QUAD 306 are separate power supplies for each channel, derived from separate secondary windings on a common toroidal transformer, and absence of fuses or relays in the signal path, and a signal-to-noise ratio of 110dB. It is fully protected against damage, accidental or otherwise.

Details from: QUAD Electroacoustics Ltd, Huntingdon, Cambs PE18 7DB.



50MHz Oscilloscope With Digital Display

Electronic Brokers has recently introduced the Grundig MO-53 50MHz dual-channel oscilloscope to the UK market. The new oscilloscope includes many features designed to make it easy to use in areas such as R & D, production, service and education.

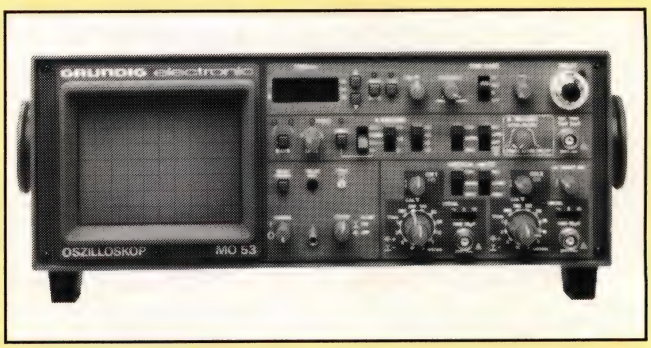
A major new feature included in the MO-53 is automatic timebase selection. Depending on the frequency of the test signal, the timebase is selected automatically and displayed digitally, so that the user has no need to search to find the correct range.

For video testing applications, the MO-53 has a field and line selector, allowing the defined selection of the field 1 or field 2 to take place automatically. Triggering occurs approximately ten lines ahead of field re-start.

Other features of the MO-53 include the full −3dB bandwidth of 50MHz being maintained at the smallest deflection factor of 2mV/cm, and the facility for inverting both Y-channels to ensure true displays of X/Y characteristic curves.

Full service and support for the Grundig instrument range is provided in the UK by Electronic Brokers.

Details from: Electronic Brokers Limited, 140–146 Camden Street, London NW1 9PB.



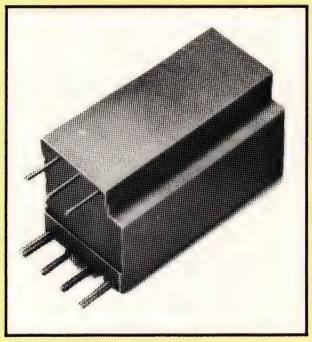
WHAT'S TO COME...

Programmable plug from Aries Electronics

A new 7 pin programmable plug is now available from Aries Electronics. Capable of being programmed up to thousands of variations, the device features an extra long handle for ease of insertion when working with densely populated p.c. boards.

The plug allows the development of individual programs which can be indentified by simply numbering the outer shell. To give even greater variation in programming any number of pins can be accommodated while polarising pins on any spacing or other variables are possible.

Details from: Aries Electronics (Europe), Alfred House, 127 Oatlands Drive, Weybridge, Surrey KT13 9LB.



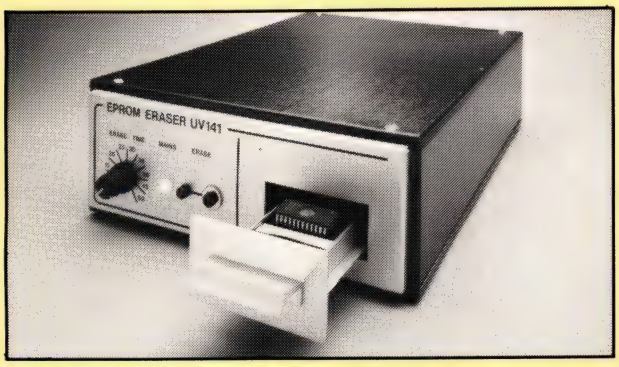
EPROM Eraser from GP Industrial Electronics

An EPROM eraser—which is capable of erasing up to 14 EPROMs simultaneously by exposing them to short-wave, ultra-violet radiation – is now available from GP Industrial Electronics.

Called the MODEL 141 EPROM ERASER, the device incorporates an electronic timer adjustable from 5 to 50 minutes in discrete steps. This provides a very useful "set and forget" facility which prevents accidental over-exposure which can shorten an EPROM life.

The 141 also features an easy-to-use slide-in tray for the loading of EPROMs, and panel indication to show when the device is in use. It is available for around £88.

Details from: GP Industrial Electronics, Unit E, Huxley Close, Newham Industrial Estate, Plymouth.



Home-Base CB Power Supply from a Kit

CB radio enthusiasts can power their mobile radio units from the mains with a new high quality power supply kit from Electronic and Computer Workshop Ltd. (ECW).

The kit, the K2556, is designed primarily for home-based applications, providing a regulated d.c. output—nominally 12 volts—but adjustable from 11 to 13·5 volts d.c. Maximum current rating is 3·5 amps.

All the necessary items are supplied with the kit, including a high quality p.c.b., all electronic and mechanical components. Instructions are included to make assembly and testing very simple.

Full overload protection is included with an overload l.e.d. Although designed for CB applications, the performance of the K2556 makes it suitable for a wide range of amateur radio and laboratory applications.

ECW can supply the kit at a price of £30.87 including p&p and VAT.

Details from: Electronic and Computer Workshop Ltd, 171 Broomfield Road, Chelmsford, Essex CM1 1RY.

POINTS ARISING...

There are no points arising from articles published in the March issue of Practical Electronics, but we have a Bytebox Update on page 26. Bytebox was published in Practical Electronics, October and November, 1985.

COUNTDOWN

Events, diary dates and forthcoming attractions

Practical Electronics gives you the dates that matter. We hope to expand the countdown page to bring news of more regional events as we appreciate that many readers have difficulties getting to the larger shows based mainly in London or Birmingham.

If you are organising any electrical, computing, electronic, radio or scientific event, big or small, drop us a line. We shall be glad to include it here. Address details to Countdown, Practical Electronics, 16 Garway Road, London W2 4NH.

NOTE: some exhibitions detailed here are trade only. Please check details and dates before setting out, as we cannot guarantee the accuracy of the information presented here.

Amstrad Computer Show May 31–June 1. Novotel, Hammersmith. **K**
Atari Computer Show Mar. 7–9. Novotel, Hammersmith. **K**
Electro-Optics/ Laser International Mar. 18–20. Metropole, Brighton. **B.**
Robotics and Automated Systems Mar. 25/26. Imperial College. **L.**
CAD '86 Apr. 8–10. Metropole, Brighton. **J**
Internepcon Production Show Apr. 8–10. NEC, Birmingham. **B**
British Electronics Week Apr. 29–May 1, Olympia. **M**
East Suffolk Wireless Revival May 25. Civil Service Sportsground, Ipswich. **C**
SCOTELEX '86 June 3–5, Royal Highland Showground, Edinburgh. **D**
Software '86/Business Computer '86 June 3–5. Earls Court. **E**
Amateur Electronics Exhibition July 12–20. Esplanade, Penarth. **A**

A B.A.E.C. ☎ 0222 707813
B Cahners ☎ 01-891 5051
C Ipswich Radio Club ☎ 0473 44047
D Institution of Electronics ☎ 0706 43661
E Reed Exhibitions ☎ 01-643 8040
F ASCE Ltd. ☎ 06268 67633
G Electrex Ltd. ☎ 0483 222888
H Online ☎ 01-868 4466
I Trident Int. Ex. Ltd. ☎ 0822 4671
J Butterworth Scientific Ltd. ☎ 0483 31261
K Database ☎ 061-456 8383
L Imperial College ☎ 01-589 5111
M Evan Steadman ☎ 0799 26699

WHAT'S HAPPENING . . .

RECOGNITION AT LAST

A RECENT report in the *Sunday Times* suggests that engineers and technologists will, at last, be recognised as important contributors to the management of major organisations. In the past, managers have come, primarily, from financial backgrounds and more recently from marketing, However, especially in America, in the 1990's the information technology specialists will have become the dominant group among the executives running major organisations.

Also, companies will be looking for the entrepreneurial spirit and the ability of its employees to diversify.

COMPUTER ALIEN REPELLENT

GRiD Compass portable computers, already used by NASA on board numerous space shuttle missions are to be used to ward off alien invaders in outer space.

The computers are not the latest piece of hardware to be deployed in the current US Star Wars technology, but are to play a part in "ALIENS", the follow up to Twentieth Century Fox's classic 1979 work of science fiction, "ALIEN".

Twentieth Century Fox set designers got in touch with GRiD Systems in Reigate after they had read about the GRiD portable being used in the NASA space shuttle programme.

On the subject of space, the next Amateur Radio satellite in the Phase-3 series is nearing completion as teams in Marburg, West Germany and the United States close in on important milestones leading to an anticipated August, 1986 launch. Plans call for a launch aboard an Ariane 4 this August, however, a set-back in the Ariane V16 launch from January to February may push the actual launch of Phase-3C into September.

AN EYE FOR PERFECTION

COMPUTERS can now think fairly 'straight', make decisions, listen and speak. In fact, there isn't much they can't do.

They are constantly being improved, in an effort to emulate human senses and responses, but are still essentially blind. There has been a great deal of research into visual recognition but with relatively poor results.

"Human vision is hindered by subjectiveness of judgments"

However, whilst being unable to match the human eye in being able to perceive and identify many and varied aspects, they can in some cases offer certain improvements over human sight. Battelle, a US concern, in conjunction with a range of interested companies is to conduct a study of automated visual inspection systems particularly connected with manufacturing industry. Recent developments in sensor technology, electronic image processing, pattern recognition and computer technology is leading the way for further improvements in automated visual inspection.

Gunter Seger of Battelle says that human vision is hindered by the subjectiveness of judgments and limited possibility of standardisation—areas that automation can handle very well. In simple terms, this means that machines can be easily programmed to look for specific faults or characteristics and can do it with great accuracy.

It won't be long before robots take the place of humans in most of the mundane jobs in industry. People and governments now accept this fact. How long will it be, though, before robots take the place of the inventors of robots?

INFORMATION TECHNOLOGY —STILL A LONG WAY TO GO

SCOTTISH Equitable Life Assurance Society (SE) has now introduced a mortgage quotation service located in branch offices and available to insurance brokers and building societies equipped with Prestel equipment. Having had a taste of 'IT', SE have approached Langton Ltd., a consulting firm, with a view to full scale involvement in Viewdata technology. This has resulted in the addition of a personal pension quotation service on Viewdata and the possibility of future linking of their Burroughs mainframe computer, directly into the Prestel network.

SOURCE PACT EXTENDED

SINCE 1981, Philips and Fairchild have operated an alternative source pact which allows each other to produce certain i.c.s designed by the other party. This arrangement has recently been extended to include 90 new high performance FAST TTL (Fairchild Advanced Schottky TTL) devices.

A strong alternative source position is critical to growth of this relatively new TTL family, which is now estimated to be expanding faster than any other TTL line. Although many semiconductor houses do operate similar agreements, there should be more, if future chip shortages are to be avoided. Maybe the answer is an international, multi company technology exchange, each company offering their own designs.

NEW IEC SYMBOLS

THE FINAL publication in a landmark 13-part series dealing with graphical symbols for diagrams will soon be available from the International Electrotechnical Commission (IEC).

This new publication, which is the culmination of several years work on the part of IEC Technical Committee No. 3 —Documentation and Graphical Symbols—provides general information, a general index, and cross-reference tables for the 12 other parts of the graphical symbol series which have been published previously.

Part 1 brings together information needed to use the entire series to its maximum advantage by providing definitions of graphical symbols, their presentation, numbering, and use.

All the symbols presented in this series have been adapted for computer-aided drafting systems. Because these systems require that each symbol have a reference point located at a grid intersection, a transparent grid is supplied with this part of the standard to facilitate the selection of a suitable point.

The now complete 13-part series is a unique tool for users across the entire gamut of the electrotechnology field—from engineeers, to designers, institutions, manufacturers and others. It gathers together world-accepted symbols and graphic component symbols and allows everyone in the electrical and electronic industries to communicate with complete understanding, graphically. Throughout the series, symbols and their alternate acceptable forms are given with explanations in English and French.

AMSTRAD SERVICE

AMSTRAD has announced that 0277 230222 has been designated as the "Customer Service Number" at the company's Brentwood headquarters.

BOOKS AND LETTERS PAGE

Dear Editor

Over many years, I have become an ardent 'taper', including reel to reel, but more especially I refer to cassette tapes, and a means of wiping them clean.

There are many times I would like to clean, i.e. bulk erase, a tape after I have edited off it what I want, and the only method seems to be either to record over the existing stuff, which I don't find satisfactory, I'd rather have a clean start, or to run it at normal speed through a recorder with the record level down low. In which case it is a long job.

I've asked at many stores for a bulk eraser for cassette tapes (which would do my micro cassettes, too), without success. None have I seen advertised, and over the years I've bought other mags than P.E. to see what chances there were.

One is advised to 'keep tapes away from sources of magnetism' so I've held them close to the transformer of my tuner, tape recorder, etc. but haven't had a 'damaged' recording. I thought perhaps a tranny rigged up might make an eraser. No luck.

Can you tell me, can I make one of these, or do you know if there is such a thing available?

Des. H. Reed, N. Yorkshire.

Dear Mr. Reed

Sorry to hear of your problem but we don't know of any such device available. Is the quality of recording over previous material, that bad? If it's only the pauses between recording that you're worried about try a voice activated switch wired to the motor (there's one this month in PE).

Editorial

Dear PE

Can you please help me to find a semiconductor, TIS 151 for the Modular Mixer and Audio Power System project? I have tried all the shops but they have never heard of it.

What rate of speaker can be used for this?

Mr. J. Worton, Surrey.

Dear Mr. Worton,

I was sorry to hear that you have experienced some difficulty obtaining the TIS 151 Darlington transistor specified in the Modular Audio System. These can be obtained from several suppliers (including R.S. Components Ltd.) and cost around 50p.

As regards loudspeaker ratings, any suitably rated loudspeaker system exhibiting an impedance of between 3 ohm and 15 ohm should be ideal. In most cases this will probably comprise several loudspeakers wired together (in series or parallel depending upon the individual impedances) so that the power is suitably shared between them. Two 15 ohm speakers rated at 25W would, for example, be connected together in parallel (taking care to ensure correct phasing) to produce a single loudspeaker system rated at 7·5 ohms-50W.

Wishing you every success with the project,

Michael Tooley, author

Dear Sir

In the October 85 issue of PE, you published a letter from me, where in general I had a moan regarding chip and other semiconductor manufacturers/ distributors and their lack of any interest in a keen hobbiest like myself and thousands more.

Response was very poor in that I still had nothing from that sector, but a couple of individuals wrote to me and helped best they could! One suggested I write to Gothic Crellon, who did indeed send many data sheets. Motorola finally answered the call with a list of sheets and where to get them from (distributors).

One, on the list, was STC who I had tried before, so I tried them again, and then again at their local office, but all to no avail. Motorola say they are a main distributor of goods and DATA SHEETS!! Yet every year they send me their catalogue?? Sorry STC I don't think we will be ordering our goodies from you!!

Could you imagine my surprise when two days ago I received a ring binder from a very kind chap full of very useful data sheets, but the great surprise was this chap lives in Ontario, yes the one in Canada, and so to Brian Deschene many thanks . . . again.

We still needs lots of data sheets and the offer is still open. Four hundred of us want to add various circuits to our home built Z80A computer system, but we will only buy from those who help us.

Are Texas and GI dead???

Mel Saunders, Leicester.

Dear Mr. Saunders (and others)

We are glad that there are some people around who are prepared to go to some trouble to help, but it shouldn't be left to the odd one or two. Come on you big boys (including STC), lend a hand.

Editorial

Dear PE

As I do not take any Electronics magazines regularly, could you tell me if there were any errors in the Mono Stereo Echo Reverb article published Sept '84?

I intend to make the unit for a straight delay (for PA use). Do you know where I can just get the p.c.b.s.

Mr. A. T. Yarnold, Southampton.

Dear Mr. Yarnold

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Editorial

MICROPROCESSOR SYSTEMS ENGINEERING
J. Ferguson—Addison Wesley. ISBN 0-201-14657-6
303 pages paperback. £12.95

"Recent trends have shown an explosive growth in the number and complexity of microprocessor applications, accompanied by a sophistication of the hardware and software tools needed to develop and maintain them."

Microprocessor Systems Engineering attempts to gather together in one book all the concepts, skills and practicalities of this diverse and often complicated subject. The first chapter categorises the various forms of microcomputers and details the general aspects of micro based systems.

In chapter two, the fundamentals of four specific processors are dealt with, these being: the 6502, Z80, 8088/8086 and the 68000. The next chapters deal with aspects of software production, testing, debugging and system development. The final chapters deal with such subjects as interfaces and peripherals, LAN's and servicing.

R.M.B

THE TRANSDUCER PROJECT BOOK
Michael J. Andrews—Tab Books Inc. ISBN 0-8306-1992-5
130 pages paperback. £7.95

The Transducer Project Book is suited to the beginner. There is a minimal amount of electronics involved with each project but the principles which are used, are fully explained at each stage.

Transducers, nowadays, are often associated with computers. Most of the projects in this book can be built and used without the need for computer interfacing or indeed a computer. Only a small section is devoted to computer applications.

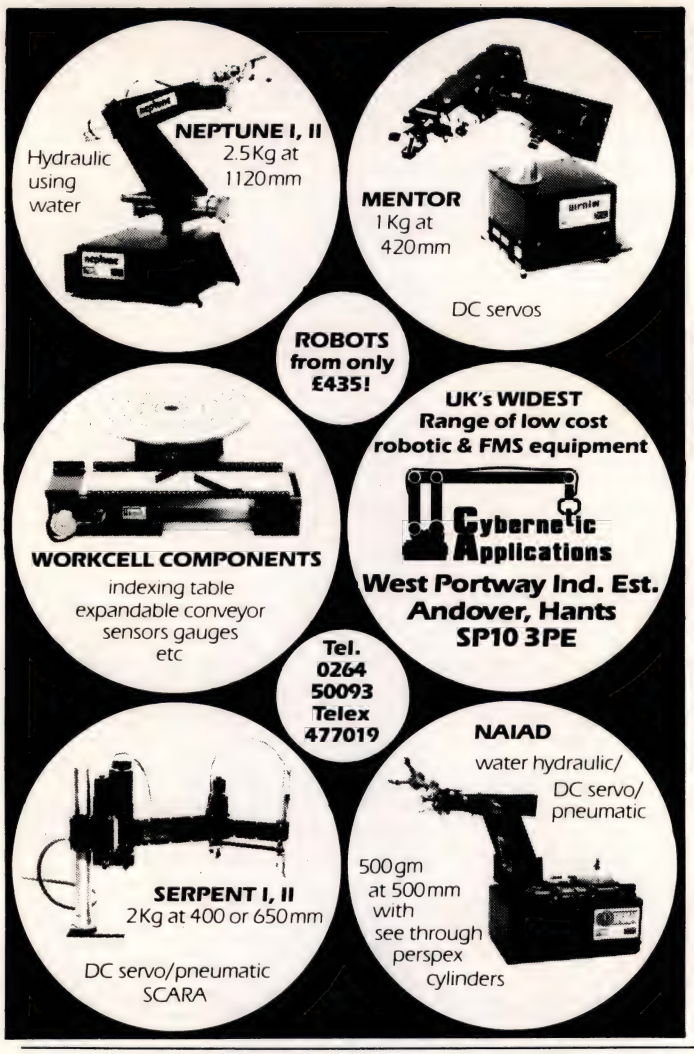
Projects described include: digital yardstick, sound activated switch, electronic balance, frequency meter and a temperature controlled crystal oven.

F.R.S.

DESIGNING IC CIRCUITS WITH EXPERIMENTS
Delton T. Hall—Tab Books Inc. ISBN 0-8306-1259-0
411 pages paperback. £15.15

This is a useful teaching aid and reference book for beginners through to experienced hobbyists. The first two chapters deal with the concepts involved with i.c.s. and essential electrical and electronic formulas.The following chapters are dedicated to particular types of circuits and i.c.s. including operational amplifiers, phase locked loops and timers. A comprehensive index allows you to find the exact subject you require.

F.B.



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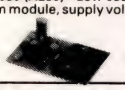

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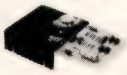

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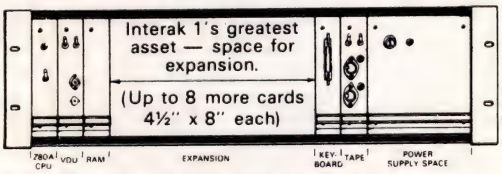

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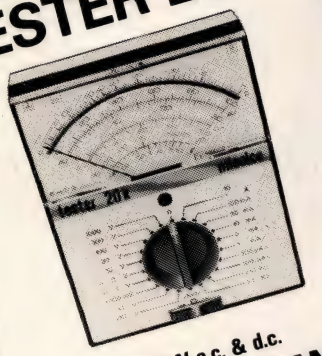

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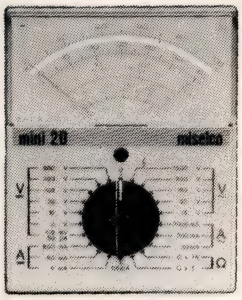

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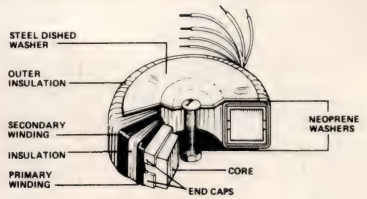

TYPE	SERIES NO.	SEC. VOLTS	R.M.S. CURRENT
15VA Regulation 19% 62 x 34 (See diagram) 0.35 Kgs Mounting bolt M4 x 12	03010	6+6	1.25
	03011	9+9	0.83
	03012	12+12	0.63
	03013	15+15	0.50
	03014	18+18	0.42
	03015	22+22	0.34
	03016	25+25	0.30
	03017	30+30	0.25
30VA Regulation 18% Size A B C 70 35 37 0.45 Kgs Mounting bolt M5 x 50	13010	6+6	2.50
	13011	9+9	1.66
	13012	12+12	1.25
	13013	15+15	1.00
	13014	18+18	0.83
	13015	22+22	0.68
	13016	25+25	0.60
	13017	30+30	0.50
50VA Regulation 13% Size A B C 80 40 43 0.9 Kgs Mounting bolt M5 x 50	23010	6+6	4.16
	23011	9+9	2.77
	23012	12+12	2.08
	23013	15+15	1.66
	23014	18+18	1.38
	23015	22+22	1.13
	23016	25+25	1.00
	23017	30+30	0.83
	23028	110	0.45
	23029	220	0.22
	23030	240	0.20
80VA Regulation 12% Size A B C 95 40 43 1.0 Kgs Mounting bolt M5 x 50	33010	6+6	6.66
	33011	9+9	4.44
	33012	12+12	3.33
	33013	15+15	2.66
	33014	18+18	2.22
	33015	22+22	1.81
	33016	25+25	1.60
	33017	30+30	1.33
	33028	110	0.72
	33029	220	0.36
	33030	240	0.33
120VA Regulation 11% Size A B C 95 45 50 1.2 Kgs Mounting bolt M5 x 50	43010	6+6	10.00
	43011	9+9	6.66
	43012	12+12	5.00
	43013	15+15	4.00
	43014	18+18	3.33
	43015	22+22	2.72
	43016	25+25	2.40
	43017	30+30	2.00
	43018	35+35	1.71
	43028	110	1.09
	43029	220	0.54
	43030	240	0.50

TYPE	SERIES NO.	SEC. VOLTS	R.M.S. CURRENT
160VA Regulation 8% Size A B C 110 45 50 1.8 Kgs Mounting bolt M5 x 50	53011	9+9	8.89
	53012	12+12	6.66
	53013	15+15	5.33
	53014	18+18	4.44
	53015	22+22	3.63
	53016	25+25	3.20
	53017	30+30	2.66
	53018	35+35	2.28
	53026	40+40	2.00
	53028	110	1.45
	53029	220	0.72
	53030	240	0.66
225VA Regulation 7% Size A B C 110 50 55 2.2 Kgs Mounting bolt M5 x 60	63012	12+12	9.38
	63013	15+15	7.50
	63014	18+18	6.25
	63015	22+22	5.11
	63016	25+25	4.50
	63017	30+30	3.75
	63018	35+35	3.21
	63026	40+40	2.81
	63025	45+45	2.50
	63033	50+50	2.25
	63028	110	2.04
	63029	220	1.02
	63030	240	0.93
300VA Regulation 6% Size A B C 110 57 62 2.6 Kgs Mounting bolt M5 x 60	73013	15+15	10.00
	73014	18+18	8.33
	73015	22+22	6.82
	73016	25+25	6.00
	73017	30+30	5.00
	73018	35+35	4.28
	73026	40+40	3.75
	73025	45+45	3.33
	73033	50+50	3.00
	73028	110	2.72
	73029	220	1.36
	73030	240	1.25
500VA Regulation 5% Size A B C 135 60 65 4.0 Kgs Mounting bolt M8 x 70	83016	25+25	10.00
	83017	30+30	8.33
	83018	35+35	7.14
	83026	40+40	6.25
	83025	45+45	5.55
	83033	50+50	5.00
	83042	55+55	4.54
	83028	110	4.54
	83029	220	2.27
	83030	240	2.08

TYPE	SERIES NO.	SEC. VOLTS	R.M.S. CURRENT
625VA Regulation 4% Size A B C 140 70 75 5.0 Kgs Mounting bolt M8 x 90	93017	30+30	10.41
	93018	35+35	8.92
	93026	40+40	7.81
	93025	45+45	6.94
	93033	50+50	6.25
	93042	55+55	5.68
	93028	110	5.68
	93029	220	2.84
	93030	240	2.60

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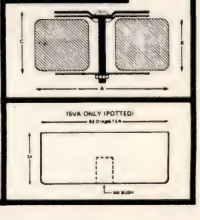


SOUND ACTIVATED SWITCH

BY R. A. PENFOLD

Bucket brigade technology coupled with a sound activated circuit provides a useful audio add-on

SOUND activated switches are mainy used in voice operated tape recorders and radio transceivers, but have other uses. Most, if not all, published sound switch designs are of a fairly basic type where the voice signal is simply coupled straight through to the cassette recorder (or whatever). This has a slight drawback in that the first syllable or even the first word is lost each time the switch is activated. This is due to the time taken for such things as the relay to close, the cassette motor to start, and so on. The start-up time obviously depends on the application and the particular equipment used, but is usually quite short at a few tens of milliseconds. The missing part of the signal does not necessarily impair the intelligibility of the signal, although it can do so, but it is obviously undesirable. It can also be accompanied by other undesirable effects, such as pitch variation as the cassette motor goes from zero to full speed.

The loss of voice signal and other problems during the start-up period can be avoided by including a delay line in the signal path so that the voice signal is delayed until the equipment has become fully operational. This sound switch includes such a facility, although it could easily be modified to act as a simple sound switch for non-critical applications if preferred. In fact, with a little ingenuity, the delay-line section could also be used in isolation for delay equalisation in a public address system or something of this nature. The delay is adjustable from a few milliseconds to a maximum of around a tenth of a second. Outputs at a low level (comparable to a microphone signal) and line level are available.

The unit is designed for use with a low impedance dynamic (200Ω or 600Ω cassette recorder type) microphone, and it operates from a 9V or 12V battery supply. The suggested relay will switch loads of up to 5A at 24V d.c. or 240V a.c., which is more than adequate for most liklely applications for the unit.

SYSTEM OPERATION

There is substantially more circuitry in this sound activated switch than in most previous designs, but the additional circuits are those associated with the delay line. Fig. 1 shows the block diagram for the unit.

Dealing with the sound switch section first, the microphone signal is at a very low level of typically under 1mV RMS, and this must be substantially boosted before it can operate a relay driver circuit. A two-stage low noise preamplifier is used, and the voltage gain is adjustable from about 54dB (500 times) to around 74dB (5000 times). This gives an output level in the region of 2V peak to peak to drive the subsequent stages.

One of these is a buffer stage which in turn drives a rectifier and smoothing network. The time constants of these gives a very fast attack time of just a few milliseconds, but a much slower decay time of two or three seconds. The fast attack time is obviously necessary in order to give the delay line a reasonable chance of eliminating the loss of the initial part of the signal. The fairly long decay time is equally important as it prevents relay "chatter", and it also eliminates problems with the relay switching off during brief pauses that occur during normal speech.

The positive d.c. signal generated across the smoothing circuit is fed to a high input impedance d.c. buffer stage which also provides a small amount of voltage gain. This drives a switching transistor which in turn drives the relay coil. A set of normally open relay contacts control the cassette motor or other load. A relay has the obvious disadvantage of being somewhat slower in operation than a semiconductor switching device. However, it still only takes nominally 16ms for the contacts to close, and the complete isolation between the switching contacts and the rest of the unit is often of great importance. A relay can also handle both a.c. and d.c. loads without any problems.

The delay line is a standard CCD (charge coupled device) or "bucket brigade" type. These are based on a series of charge storage capacitors and electronic switches, which are analagous to buckets and humans in a "human chain". The basic action is for the input capacitor to sample the input signal, and then the charge on this capacitor is passed on to the second capacitor in the chain via an electronic switch and buffer amplifier. The input capacitor then samples the input signal

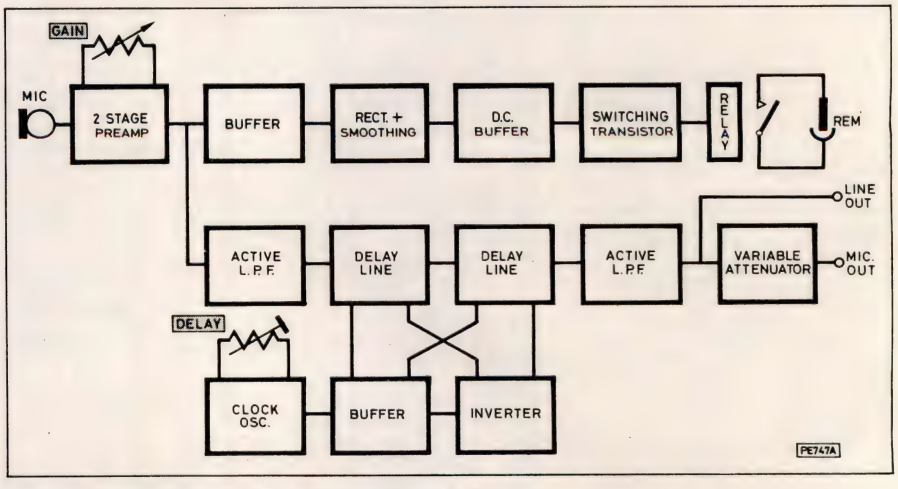


Fig. 1. *Block diagram of the Sound Switch*

COMPONENTS . . .

RESISTORS

R1,R5	1k (2 off)
R2,R3,R11, R20,R21	47k (5 off)
R4	100k
R6,R12	4k7 (2 off)
R7	3k9
R8	2M2
R9,R13, R15–R17, R22, R23–R27	10k (11 off)
R10,R18	22k (2 off)
R14	56k
R19	1k5
R28–R30	8k2 (3 off)
R31	470k

All $\frac{1}{4}$ watt 5% carbon

CAPACITORS

C1,C4	4µ7 63V radial elect (2 off)
C2,C5,C11	2µ2 63V radial elect (3 off)
C3,C14,C17, C20,C23	1n carbonate (5 off)
C6,C24	1µ 63V radial elect
C7	100n ceramic
C8	100µ 16V radial elect
C9	220p ceramic plate
C10	2n2 carbonate
C12,C15, C18,C21	10n carbonate (4 off)
C13,C16, C19,C22	15n carbonate (4 off)
C25	10µ 25V radial elect

POTENTIOMETERS

VR1	47k lin
VR2,VR3	100k sub-min horizontal preset (2 off)
VR4	1k sub-min horizontal preset
VR5	4k7 sub-min horizontal preset

SEMICONDUCTORS

IC1	TL072CP or LF353
IC2	CA3130E
IC3	4001BE
IC4,IC8	741C (2 off)
IC5,IC6	TDA1022 (2 off)
IC7	1458C
TR1,TR2	BC109C (2 off)
D1,D2	0A91 (2 off)
D3	1N4148

MISCELLANEOUS

S1	s.p.s.t. miniature toggle
SK1	3·5mm jack socket
SK2	5-pin DIN (180 degree) socket
RLA	6V 410Ω coil, s.p.d.t. contacts, open p.c.m. type
B1	9V to 12V (see text)

Printed circuit board PE 102; case about 180 × 120 × 39mm; control knob; battery connector; 16-pin d.i.l. sockets (2 off); 14-pin d.i.l. socket; 8-pin d.i.l. i.c. sockets (5 off); pins; wire; solder, etc.

again, the second capacitor passes on its charge to the third capacitor, and so on, with a continuous stream of samples being taken and passed on through the full length of the delay line to eventually emerge at the output.

This gives an output of the type shown in Fig. 2. The waveform here is not what one might expect, and the problem is due to the final stage of the delay line being unable to simultaneously maintain an output signal and receive the next sample. The output is therefore cut off during the periods when the final stage is receiving samples from the penultimate stage. The amplitude modulated squarewave output could be processed by a lowpass filter to give a proper audio output signal, but very heavy filtering indeed would be needed in order to give an output signal having a really low ripple content. The problem is considerably eased by having an extra stage at the output of the delay line which is used to maintain the output signal level while the final delaying stage receives samples. An adjustable passive mixer stage is used to combine the two output signals for minimal "glitches" on the output. The glitches are not totally eliminated, but they can be reduced to an insignificant level by lowpass filtering. This filtering is essential anyway since the output signal is a stepped waveform, and lowpass filtering is required to smooth out the steps and give a proper output waveform which matches that of the original input signal.

DELAY

There are two factors which govern the length of the delay obtained; the number of stages in the delay line and the sampling frequency. In this case we are using two inexpensive CCD chips (TDA1022s) in series, and these provide a total of 1024 delaying stages. An external two-phase clock signal is required, and this is provided by a CMOS astable plus a buffer stage and an inverter to provide the antiphase clock signal. The delay time is equal to the number of delaying stages divided by twice the clock frequency. The clock frequency must be at an absolute minimum of double the maximum input frequency, and it is this that sets the practical limit on the delay time for a given length of delay line. For intelligible speech a minimum bandwidth of about 3kHZ is required, which demands a minimum clock frequency of 6kHZ. With a 1024 stage delay line this gives a delay time of just over 85 milliseconds, which is just about adequate for this application.

A lowpass filter is needed at the input of the delay line to prevent strong signals at frequencies close to the clock frequency from entering the delay line. If this was not done a form of distortion known as "aliasing" distortion would give a very poor quality output. With a clock freqency that is within the audio range a very high slope lowpass filter is needed at the output as strong audible breakthrough of the clock signal would otherwise occur. In this case three 18dB per octave filters in series are used, giving a total roll-off rate of some 52dB per octave. The line output is taken direct from the output of the filter, but the microphone output is taken by way of a variable attenuator which will normally be used to provide about 60dB of attenuation.

THE CIRCUIT

Fig. 3 shows the circuit diagram for the preamplifier, switch, and clock oscillator stages, while Fig. 4 gives the circuit diagram for the delay line and filter stages.

Taking Fig. 3, first, the preamplifier is based on a dual low noise (bifet)

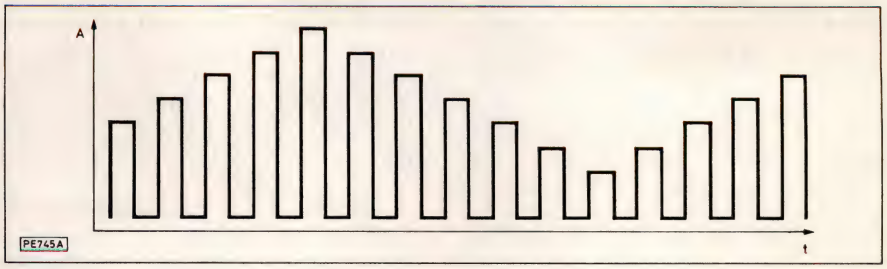


Fig. 2. *CCD output*

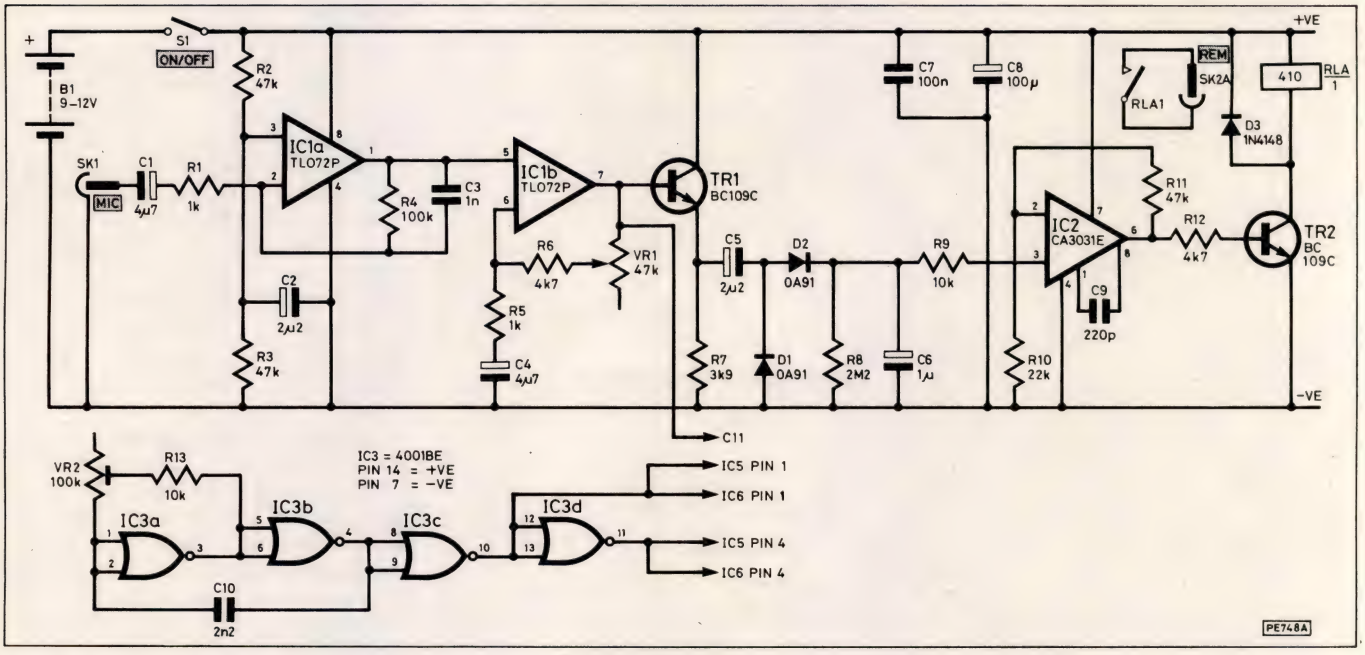


Fig. 3. *Preamplifier switch and clock oscillator stages*

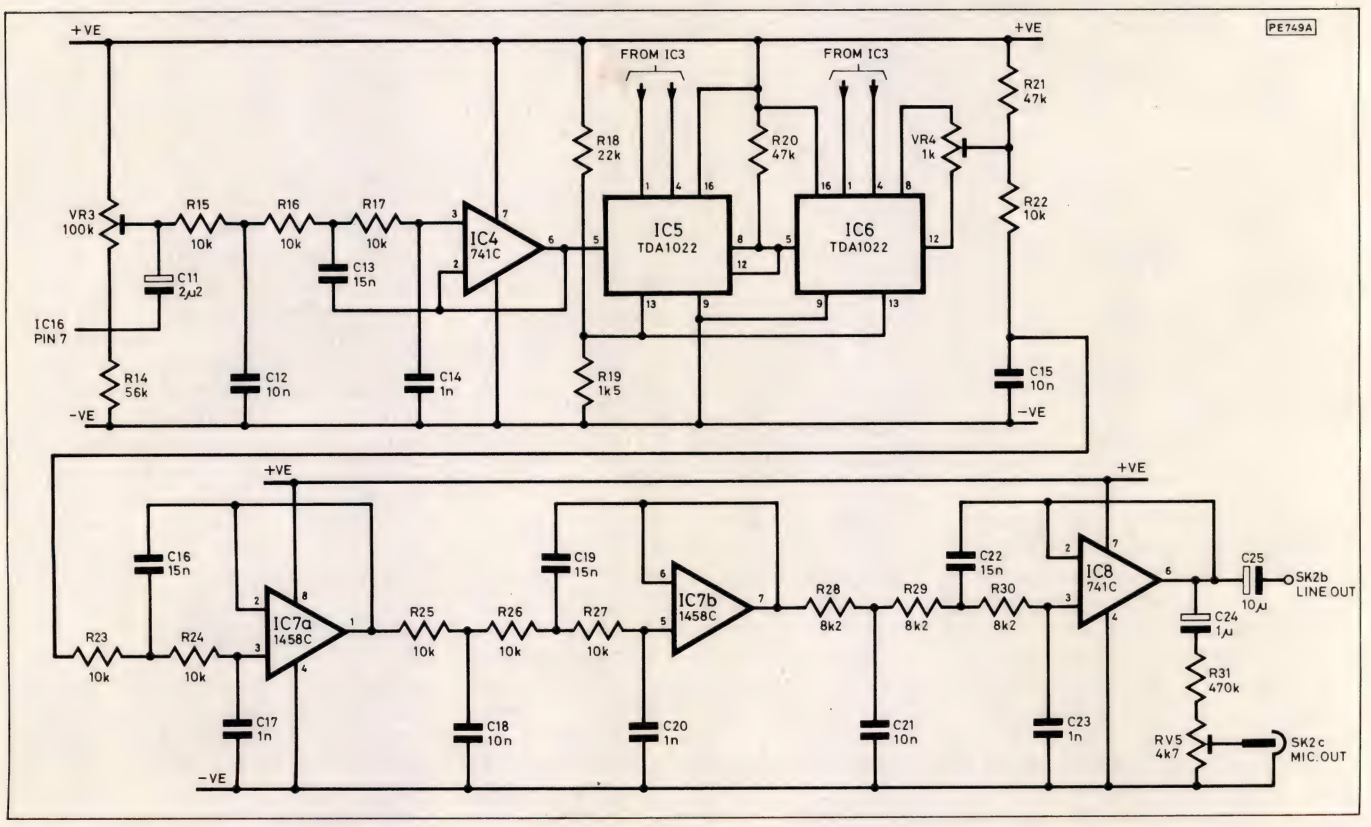


Fig. 4. *Delay line and filter stages*

operational amplifier, IC1. IC1a operates in the inverting mode and has a fixed voltage gain of 100 times. C3 introduces some lowpass filtering which helps to avoid serious aliasing distortion, but is of no real consequence as far as the switch section of the circuit is concerned. IC1a has its output direct coupled to the input of IC1b, which operates in the inverting mode with a voltage gain that is variable from 5·7 times to over 50 times by means of VR1. The signal for the delay line is taken from the output of IC1b, but the signal which drives the switch circuit is taken via the emitter follower buffer stage based on TR1. The latter is needed primarily to prevent the rectifier and smoothing circuit from placing non-linear loading on IC1b and causing distortion.

The rectifier is a straightforward two-diode half-wave type, with smoothing provided by C6. The low output impedance of TR1 coupled with the fairly low value of C6 gives a suitably fast attack time, while the high value of R8 gives only a high resistance discharge path and a relatively long decay time. IC2 is the d.c. buffer stage, and this is an operational amplifier connected in the non-inverting mode. Negative feedback resistors R10 and R11 give a low voltage gain of only about three times. IC2 is a CA3130E, and this has a CMOS output stage that enables a peak to peak output voltage virtually equal to the supply potential to be achieved. This is important in

this application as it enables the output of IC2 to go sufficiently negative to switch off the relay driver transistor, TR2. Most operational amplifiers are not suitable for use in this circuit as they would hold TR2 permanently in the on state. IC2 also has a MOS input stage which gives a very high input resistance and ensures minimal loading on the high impedance smoothing circuit. IC2 lacks an internal compensation capacitor, and discrete component C9 is required.

The chosen relay has a fairly high coil resistance so that the current consumption of the unit is kept down to reasonable proportions while the relay is activated, and battery operation is a realistic proposition. D3 is the usual protection diode to suppress the reverse voltage spike generated as the relay switches off.

IC3 is a CMOS 4001BE quad 2 input NOR gate, but here all four gates are wired to operate as simple inverters. IC3a and IC3b are connected as a standard CMOS astable circuit, and VR2 can be used to vary the clock frequency over wide limits. IC3c acts as the buffer stage and IC3d is the inverter which generates the second clock phase.

The input filter is a conventional third order (18dB per octave) type which has IC4 as the unity voltage gain buffer stage. VR3 provides a variable input bias for this stage, and due to the use of d.c. coupling throughout the delay line circuits it actually provides the bias voltage for all the subsequent stages as well. VR3 is adjusted to provide optimum large signal handling, and an output level of several volts peak to peak can be provided before the onset of clipping occurs.

Photo 1. *Internal details of the Sound Activated Switch*

Apart from the clock oscillator and filters little in the way of discrete components are required for the delay line chips (IC5 and IC6). R20 and R21 are load resistors for the output stages of these chips. The two outputs of IC5 are simply wired together and coupled direct to the input of IC6. VR4 provides mixing at IC6's outputs, and VR4 is adjusted for minimum clock breakthrough at the output. R18 and R19 provide a small bias voltage for an input on each delay line chip.

The three output filters are identical to the input filter apart from the final one. This only differs in that the filter resistors have been made slightly lower in value, which slightly improves the overall response of the filters. R31 and VR5 form the variable attenuator at the microphone output of the unit.

CONSTRUCTION

Except for the controls, sockets, and battery, all the components fit onto the printed circuit board. The printed circuit track pattern and component layout are illustrated in Fig. 5.

Although construction of the board is largely straightforward there are a few points that should be noted. IC2, IC3, IC5 and IC6 are all MOS devices which should be fitted in holders, and the other normal antistatic handling precautions should be observed. D1 and D2 are germanium devices which are more easily damaged by heat than silicon types. Take care to avoid overheating these when soldering them in place. From the electrical point of view any 6V relay having a coil resistance of about 20Ω or more and adequate contacts is suitable for use in this

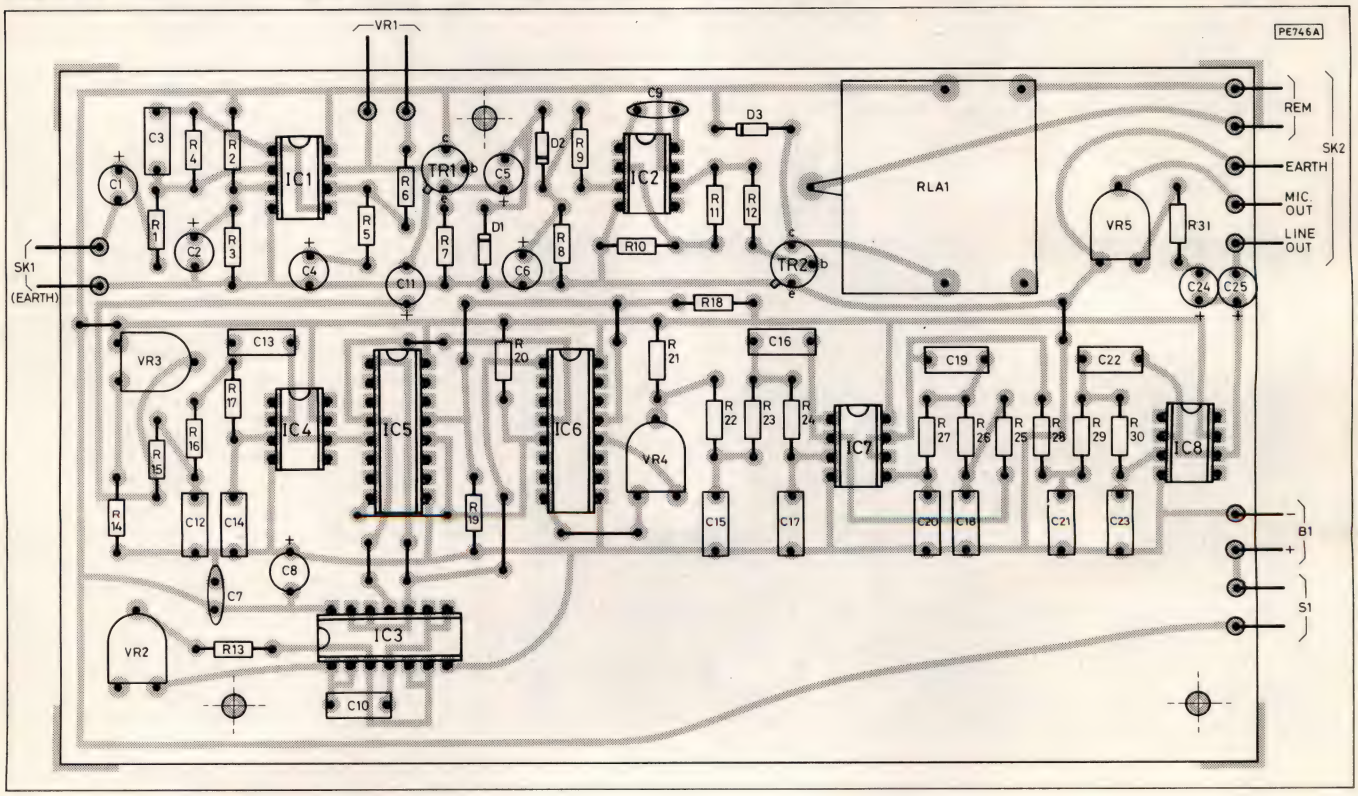


Fig. 5. *P.c.b. pattern and component layout*

circuit. It is best to use the specified type though, since it will fit direct onto the board. Alternatives, even printed circuit mounting types, would either need to be mounted off-board somehow, or the board would have to be modified to suit the different pin-out arrangement. The filter capacitors must be carbonate types, or polyester types of the same small physical size and 5% tolerance.

The case for the prototype is a plastic type having metal front and rear panels and approximate outside dimensions of 180mm x 120mm x 39mm. This is just sufficient to accommodate all the parts including a PP3-size NiCad battery. If a non-rechargeable battery is used a fairly high capacity type will be required due to the quite high current consumption of the unit. This is approximately 8 milliamps under quiescent conditions, but rises to 30 milliamps or so when the relay is activated. A PP9-size battery or six HP7 cells in a plastic holder are suitable. However, this would probably necessitate the use of a slightly larger case. The TDA1022 delay line chips have a minimum recommended supply voltage rating of 10V, but it does not seem to be essential to resort to a 12V battery supply, and good results are obtained using an ordinary 9V battery as the power source.

The controls and sockets are mounted on the front panel, and the printed circuit board is fitted on the base panel using M3 or 6BA fixings. The hard wiring is then added. A screened lead is used to connect SK1 to the board, but the other leads are made from ordinary multistrand PVC insulated connecting wire. SK2 is a 5-way DIN type on the prototype, but obviously any more convenient type can be substituted here, or separate "line", "mic. out", and "remote" sockets can be used.

Photo 3. *Front panel and case details of the Sound Activated Switch*

ADJUSTMENT

With all four prestet resistors set at roughly a middle setting the unit should work reasonably well. VR3 can be adjusted with the aid of an audio sinewave generator and an oscilloscope to give symmetrical clipping, or if suitable test gear is not available it can be given any setting that enables a high output level and low distortion to be achieved.

VR2 enables the delay time to be adjusted, and this is set for the longest delay that is commensurate with good audio quality. Anticlockwise adjustment gives increased delay time incidentally. VR4 is simply adjusted for minimum breakthrough of the clock signal at the output. VR5 is adjusted to give an output level from the microphone output that is comparable to that obtained from the microphone normally used with the controlled equipment. VR1 controls the sensitivity of the unit, but it also affects the output level of the unit. VR1 should therefore be set at a practical setting before adjusting VR5. Avoid having the sensitivity too high for the microphone in use as this will simply result in clipping of the output signal and unwanted triggering of the unit by background sounds. It is useful to have the sensitivity control as a front panel control as it is then easy to adjust it to compensate for changes in the distance from the speaker to the microphone, and different microphones if more than one type is used with the equipment. PE

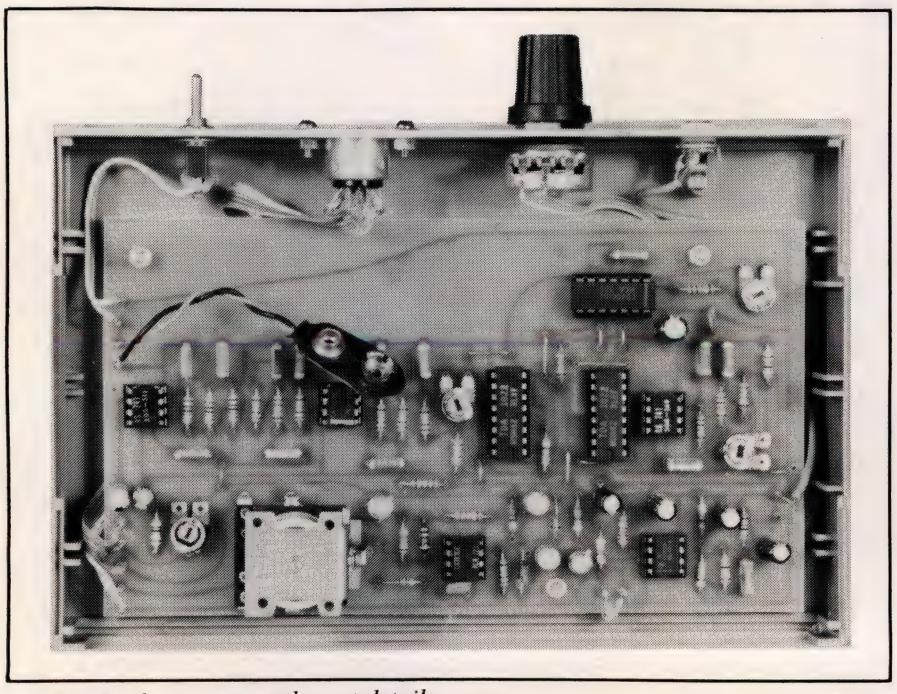


Photo 2. *P.c.b. component layout details*

THE LEADING EDGE

BY BARRY FOX

The technology behind the technology and things to come

It is hard now to sell anything in the professional or domestic audio industry unless it carries a "digital" label. Studios use digital tape to record music, which is then issued on compact disc, the 12 centimetre digital gramophone record which is read by a laser. The compact disc system is now so successful that the supply of records cannot meet the demand.

The computer industry will soon start selling CD peripherals because one CD can store 600 megabytes of data, equivalent to around 1000 floppies. The data is read-only, of course. The disc becomes an extra ROM of hitherto undreamed-of capacity. Hence the term CD ROM. It's cheap, too. A CD ROM disc costs no more to make than a music disc. As far as the disc pressing plant is concerned it makes no difference what the spiral track of sub-micron bits carries in code.

CD ROM players will be cheap, unless the computer firms profiteer. Already CD music players are selling for under £200. The raw kit of parts, chips and optics, cost manufacturers under £50 and much less in bulk. A CD ROM player does not even need the digital-to-analogue converter chip needed for music reproduction.

It is easy to transfer books and maps onto CD ROM, because the text and line structure is usually in digital code already. Modern printing presses run from an input of ASCII code on tape. The code can just as well be fed to a compact disc mastering suite. Philips has put a Dutch dictionary on CD ROM as a test. In America the Grolier publishing house has put all 21 volumes of its encylopaedia on a single $200 CD ROM. A PC database can search out entries, with access time of less than a second.

DEVELOPMENTS

New developments now follow so fast that the technical basics on which they rely get lost in a sea of commercial puff.

Compact disc sound is in pulse code modulation or PCM. The original signal is sampled at 44·1KHz and each sample described in a 16-bit word. The digital pulses or bits are recorded as a track of 15 billion pits in a 4·5 kilometre spiral track on the 12 centimetre disc. The pits are 0·1 micrometre deep and 0·6 micrometre wide. The track has a 1·6 micrometre pitch and the read-out laser is accurately focused by servo control to a one micrometre spot. By comparison a conventional vinyl LP has a groove around 50 micrometres wide, similar to a human hair, and is tracked by a diamond stylus with a curved tip of 15 micrometres radius.

Currently there are only ten factories around the world capable of pressing compact discs on a commercial scale. Although their claimed production totals nearly 100 million discs a year, only around 50 million discs a year have so far been reaching the market. Four million people round the world now own CD players and shop prices have risen to over £10 a disc. Philips of Holland has signed a joint venture deal with Dupont of the US, to press 200 million discs a year by 1990.

CODING

Although the CD format specifies 16-bit coding, Philips has been selling players since the system launch in 1983 which rely on only 14-bit decoders. Despite this, most hi fi buffs think the Philips players sound better than Japanese players which use 16-bit chips. This follows from a clever decoding trick.

Philips argued when CD was launched that 16-bit technology was not ready. Chips do not resolve the fine detail available from the last two bits. So Philips research laboratories in Eindhoven developed a technique called over-sampling which makes 14-bit chips behave like 16-bit chips.

Oversampling spreads unwanted noise over an artificially widened sound spectrum. The digital data leaves the disc in a stream running at 4·3 megabits/second. To reconstitute the original analogue waveform, the player would normally work on 44,100 samples a second to match the original 44·1kHz coding. Instead the Philips player feeds the 16-bit data stream into a shift register which quadruples the sampling frequency, so that three dummy bits are created for each bit which matters.

INCREASE SAMPLING

When the sampling frequency is quadrupled, from 44·1KHz to 176·4KHz, the effective audio bandwidth is also quadrupled, from 22KHz to 88KHz. There is of course no audible signal outside the original 22KHz bandwidth, but the unwanted background noise produced by the digital system is now spread over the full 88KHz range. So 75% of the noise is above the range of normal hearing and can be removed by filtering. This reduction of noise compensates for the introduction of noise by the use of 14-bit chips instead of 16-bit chips.

There is an added benefit. Because the noise filter can operate over a very wide band of audible frequencies, it can operate on a smooth slope. Sharp action filters, which try to chop off everything immediately above the audio range, introduce audible "ringing" distortions of their own.

OBVIOUS

For three years now audio engineers have been asking the obvious question. How would a genuine 16-bit chip sound with four times oversampling? In theory the performance becomes equivalent to 18-bit. Philips has been promising to launch a 16-bit oversampling player for the best part of a year now. They were due in the shops last autumn. Then late 1985. Then early 1986. Even as Philips' adverts for 16-bit players appeared in magazines, and as Philips' UK subsidiary Mullard offered 16-bit chip packages for sale to other manufacturers, Philips put the project on hold. The chips don't yet work properly. Resolution is nowhere near 16-bit, because the chip cannot resolve all the small signal steps accurately. The resolution may vary too, with time and temperature. Foolishly Philips released a prototype 16-bit player for review. The reviewer measured performance and found it poor. Production at Philips' factory in Hasselt, Belgium was postponed yet again. If nothing else it proves Philips' point of three years ago; namely that

(continued on page 39)

SETTING THE STANDARDS

BY RICHARD BARRON

Two micro-system back plane standards—the STEbus and the PE Hobby bus

THE electronics hobby has changed dramatically in recent years, largely due to the influence of LSI digital i.c.s and inexpensive personal computers. It was inevitable that cheap micros would give a new dimension to the hobby; providing new challenges as software engineering and computer applications projects became as much a part of amateur construction as radio receivers and power supplies.

However, whilst home micros have indeed given rise to the appearance of countless digital and analogue projects, interfaces and controllers, they have also created a number of problems, not least of these being compatibility. A multi-channel mains controller designed for a particular micro will, probably, not work with another computer.

This problem is not unique to the electronics hobbyist but is common to industrial and commercial designers. Printers, plotters, disc drives and monitors are often designed, exclusively, for one type of machine, and in many cases, cannot be used with different models. Sometimes, this is intentional as it can be good marketing strategy to sell a low cost but powerful computer which, on the face of it, seems an attractive package. Many people do not realise the pit-falls of exclusive add-ons until too late. They become a captive audience to a single range of accessories.

Similarly, in the manufacturing industry, robots, automated manufacturing systems, various control systems and a multitude of other devices are now available which may only be installed to certain and exacting specifications.

SOLUTIONS

Despite widespread awareness of the problems which confront the industry, solutions which provide compatibility have not, as yet, been widely accepted. And, in many cases, new standards have, themselves, created further problems or restrictions. For example, a group of mainly, large, Japanese companies including Hitachi, Mitsubushi and Toshiba, under the guidance of Microsoft (the software house), introduced the MSX standard. This standard was intended, primarily, to ensure software compatibility between machines manufactured by different companies, and secondly to standardise hardware facilities. To a large extent, the software solution was successful, despite a few minor problems. The same is true for the hardware approach; compatibility of peripherals was achieved. But, inherent restric-

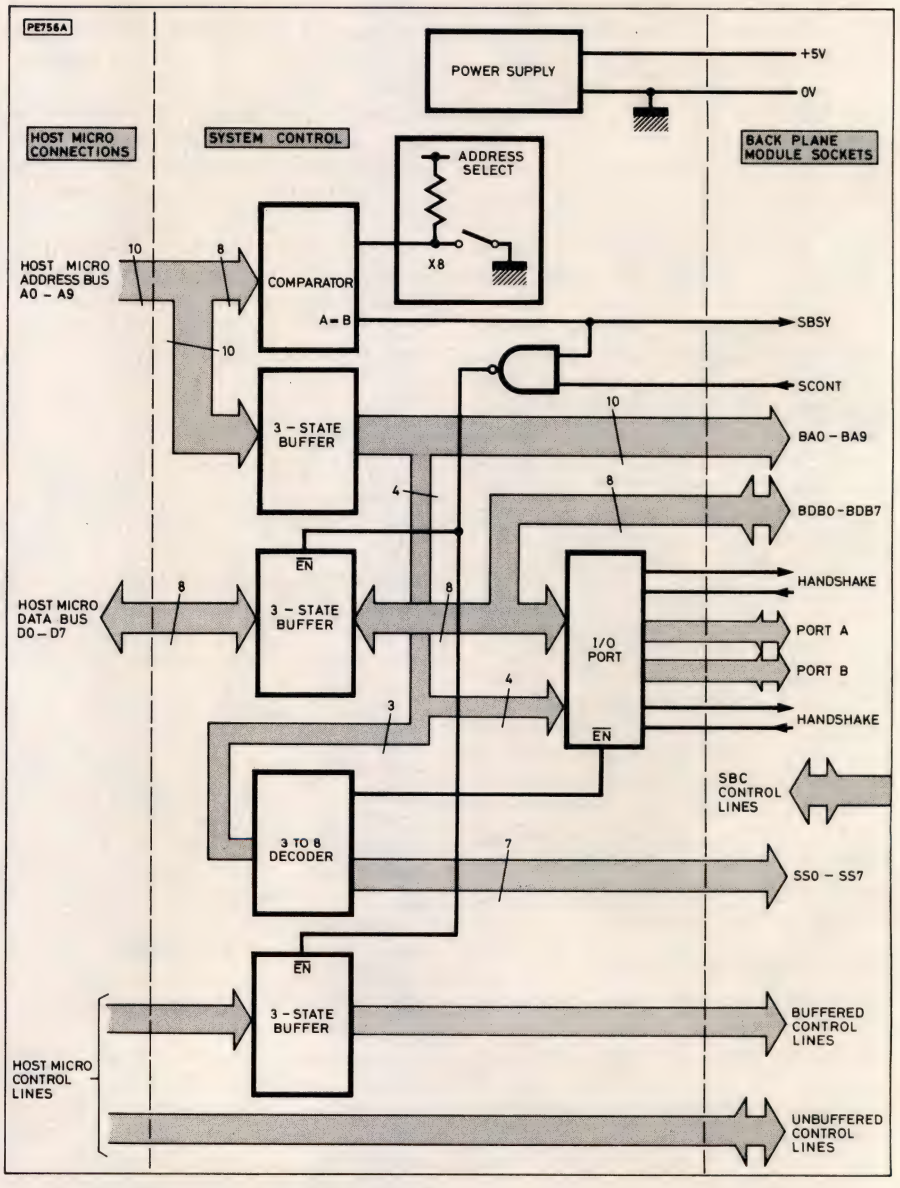


Fig. 1. *Block diagram of the PE Hobby Bus*

Table 1. *Compatible micros*

COMPUTER	PROCESSOR
ZX81	Z80
ZX SPECTRUM	Z80
BBC	6502
MSX	Z80
COMMODORE	6502
VIC-20	6502
AMSTRAD	Z80
RML	Z80
VARIOUS	6502
VARIOUS	Z80

tions in the design parameters meant that MSX machines are limited, and are unable to take advantage of more advanced technology and new developments.

Other examples of standardisation in the computer industry are those of communications protocols, such as the RS232 serial link and the parallel IEEE488. These two standards have, in fact, been widely accepted.

Many peripherals, particularly printers, are quoted as being IEEE488 compatible. Even so, it seems that there are still problems. Although the various signal standards are clearly defined, it has become apparent that manufacturers have not yet agreed on the type of connection leads, connectors or colour codes. The results are obvious.

Clearly, therefore, there are two important lessons to be learnt from these examples. Firstly, design standardisation should not impose unneccesary restrictions upon future developments. Secondly, standards should be clearly defined, allowing no room for ambiguity. With this criteria in mind, PE has decided to adopt two clear standards in an effort to provide readers with many advantages without sacrifice to flexibility or future development possibilities.

Our two standards will feature extensively in future projects and articles, and should prove interesting to all readers, whether hobbyists or professionals, actively engaged in the industry.

Designs for interfaces and peripherals will, for the first time, be compatible with almost any home micro. No longer will speech synthesisers designed for the Spectrum be useless to BBC owners. Even if you don't already own a computer, our inexpensive SBC projects will allow you full control over an enormous range of micro projects.

PE HOBBY BUS
The PE standard interface for all home micros

Over the last few years, PE has published a large selection of computer projects including speech synthesisers, amplifiers, robot and printer interfaces, and digital and analogue ports. It's unfortunate that they, all, could not be used with a variety of host micros. Each project was dedicated to one particular machine, yet with a little thought could have been modified to suit most others.

By their very nature, computer ports and peripherals are very much alike, regardless of manufacturer or CPU employed. All home micros have an address bus, data bus and a number of control lines. Some have standard I/O ports. The differences between machines are usually minor obstacles to compatibility, such as I/O address space, bus connectors or program languages.

The PE Hobby Bus Standard is designed to allow for these minor differences and permit almost any machine to have full control over a wide range of peripherals and interface devices.

FLEXIBILITY

A block diagram of the PE Hobby Bus is shown in Fig. 1. A flexible I/O section provides buffering of address and data lines and input/output decoding. The spare I/O area for any host micro may be set up via only a few switches, giving enormous software and hardware flexibility. A short list of compatible micros is given in Table 1.

Also included, as standard, on the Hobby Bus, are 16 I/O lines plus four handshake lines which can be accessed from any position along the bus. These lines may be used in conjunction with a range of peripherals and can be controlled by any host micro.

In addition to the standard I/O lines, a further seven decoded Select lines are available, which together with the buffered control lines permit almost any type of device to be connected. A few of the planned devices which may be supported by the Hobby Bus are shown in Table 2.

Table 2. *Support projects*

PROJECTS	ISSUE
SPEECH SYNTH	TBD
ANALOGUE PORT	OCTOBER
BATTERY BACKED RAM	TBD
MINI PRINTER	TBD
ROBOT/SERVO CONTROLLER	TBD
SBC-1	JUNE
KEYBOARD/DISPLAY MODULE	JULY
EPROM PROGRAMMER	TBD
TBD = To Be Decided	

BACKPLANE

The PE Hobby Bus system is based around a 64-line backplane which allows up to seven uniquely addressed modules to be connected as well as a selection of other devices such as SBC's, PSU's or memory cards.

Modules are connected to the system via DIN 41612 standard, 64-way a-c, connectors. The module p.c.b.s are standard size Eurocards (100mm × 160mm) and module I/O connections are made via 15-way, D-type connectors. All components will be widely available and by using standard items, cost will be kept to a minimum. A schematic representation of the backplane and module sockets is shown in Fig. 2.

The on-board power supply, supplies 5V d.c. at around 750mA. This should be sufficient for most applications but should more current be required, this can be achieved via a plug-in module. Additional lines have been designated for other voltages for op-amp supplies, programming voltages and power fail requirements.

CONNECTOR PIN ALLOCATIONS

All of the designated signal lines are listed in Table 3. A brief description of some of their functions is given below.

BA0–BA9: These are the least significant 10 address lines. All connections

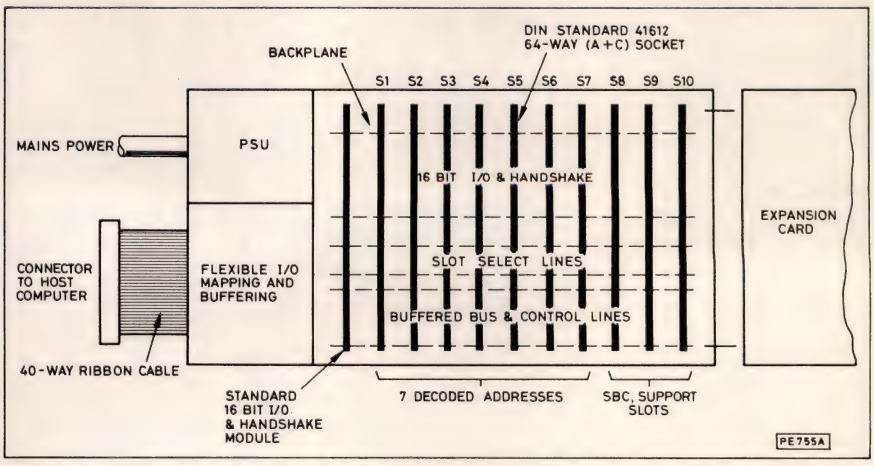
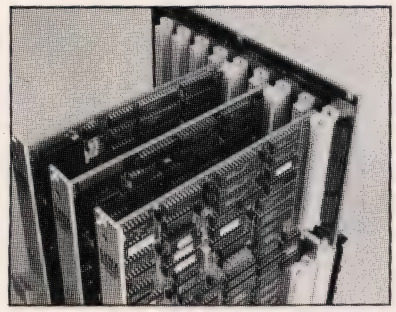


Fig. 2. *Block diagram of the backplane*



An industry standard backplane employing double Eurocard connectors

to these lines should be via three-state buffers.

DBB0–DBB7: These are the data transfer lines and are bi-directional via three-state buffers.

I/O A and I/O B: These are two 8-bit I/O ports and may be used to communicate with other modules or control peripheral devices. Strobe lines are also available.

SCONT: The System Control line is used to give bus control to any other modules, especially SBC's which may be used to control the Hobby Bus.

SBSY: This line indicates that the host micro has control of the bus.

SS0–SS7: These are the Slot Select lines used to select a particular module position (slot) on the bus. It should be noted that they are not available at all connector points. Seven connectors are designated as slots. Thus, Slot 1 would have SS1 available at pin 6, Slot 2 would have SS2 available at pin 6, and so on, up to Slot 7.

Next month we will publish Part 1 of the constructional series based on the PE Hobby Bus. This will include the complete circuit diagram and further details of system operation.

THE STEbus (IEEE 1000)
The 8-bit IEEE standard for all 8-bit processors

The STEbus is the only available 8-bit bus on a single Eurocard likely to gain full IEEE approval. It is now in the final stages of becoming the IEEE 1000 standard.

The IEEE 1000 bus was designed by engineers for engineers and was the result of a growing need for a compatible and flexible bus standard which could offer reliability and acceptance. As it now stands, the STEbus has become the one truly manufacturer independent standard, as a result of a team effort, from a number of engineers and consultants, from a variety of organisations. There are now manufacturers and distributors of STE products throughout the world, including the UK, Europe and the USA.

Table 3. *PE Hobby Bus System connection details*

PIN	A	B
1	0V	0V
2	12V	−12V
3	BA4 } BUFFERED	BA5 } BUFFERED
4	BA6 } ADDRESS	BA7 } ADDRESS
5	BA8 } LINES	BA9 } LINES
6	SS1–SS7 (SLOT SELECT)	SCONT (SYSTEM CONTROL)
7	SBSY (SYSTEM BUSY)	INT
8	BDB0 } BUFFERED	BDB } BUFFERED
9	BDB2 } BI-DIRECTIONAL	BDB } BI-DIRECTIONAL
10	BDB4 } DATA BUS	BDB } DATA BUS
11	BDB6 }	BDB }
12	BA0 } BUFFERED	BA1 } BUFFERED
13	BA2 } ADDRESS LINES	BA3 } ADDRESS LINES
14	I/O A0	I/O A1
15	I/O A2 } I/O	I/O A3 } I/O
16	I/O A4 } PORT A	I/O A5 } PORT A
17	I/O A6 }	I/O A7 }
18	ASTB (PORT A STROBE)	ARDY (PORT A READY)
19	I/O B0	I/O B1
20	I/O B2 } I/O	I/O B3 } I/O
21	I/O B4 } PORT B	I/O B5 } PORT B
22	I/O B6 }	I/O B7 }
23	BSTB (PORT B STROBE)	BRDY (PORT B READY)
24	$\overline{\text{WAIT}}$	$\overline{\text{NMI}}$
25	$\overline{\text{RESET}}$	$\overline{\text{HALT}}$
26	* RD/$\overline{\text{W}}$ (READ/WRITE LINE)	* 10RQ/Ø2 (I/O REQUEST CLOCK)
27	* MREQ/RD (I/O CONTROL)	* SYNC/M1 (I/O CONTROL)
28	$\overline{\text{SBC INT}}$	$\overline{\text{SBC WAIT}}$
29	$\overline{\text{SBC RESET}}$	$\overline{\text{SBC NMI}}$
30	$\overline{\text{SBC HALT}}$	PSUMON (PSU MONITOR)
31	V_{STBY} (STANDBY POWER)	V_{PGM} (PROGRAM SUPPLY)
32	+5V	+5V

Table 4. *STEbus connector pin designations*

PIN	A	B
1	0V	0V
2	+5V	+5V
3	D0	D1
4	D2	D3
5	D4	D5
6	D6	D7
7	A0	0V
8	A2	A1
9	A4	A3
10	A6	A5
11	A8	A7
12	A10	A9
13	A12	A11
14	A14	A13
15	A16	A15
16	A18	A17
17	CM0	A19
18	CM2	CM1
19	ADRSTB	0V
20	DATACK	DATSTB
21	SYSERR	0V
22	ATNRQ0	SYSRST
23	ATNRQ2	ATNRQ1
24	ATNRQ4	ATNRQ3
25	ATNRQ6	ATNRQ5
26	0V	ATNRQ7
27	BUSRQ0	BUSRQ1
28	BUSAK0	BUSAK1
29	SYSCLK	+VSTBY
30	−12V	+12V
31	+5V	+5V
32	0V	0V

Because of its popularity and acceptance in industry, PE has decided to adopt the IEEE 1000. There are already 100's of products available for the standard including SBC's, digital and analogue cards, power supplies, memory cards and disk controllers. As well as these, PE will be publishing a number of designs which will all be compatible.

BUS FEATURES

The STEbus works with any 8-bit microprocessor using both synchronous and asynchronous, non-multiplexed data transfer. It has a multi-user capability with eight attention request levels and an interrupt acknowledge cycle. Up to 1Mbyte of memory can be addressed with 8-bit data transfer at 5–6MHz bandwidth.

Power supply requirements are +5V, 0V and ±12V. All the signal and power lines are available on a 64-way backplane with 64-way a and c connectors conforming to DIN standard 41612. The module cards are based around a single Eurocard (100mm × 160mm) format and completed assemblies may be mounted in 19 inch rack systems. A complete list of STEbus Signals and pin designations is shown in Table 4. These will be described in greater detail in forthcoming projects. PE

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VP4	200	½-1 Watt Resistors Mixed	£1.00
VP5	200	Assorted Capacitors All Types	£1.00
VP6	200	Ceramic Caps. Miniature – Mixed	£1.00
VP7	100	Mixed Ceramic Disc. 1pf-56pf	£1.00
VP8	100	Mixed Ceramic Disc. 68pf-0.15pf	£1.00
VP9	100	Assorted Polyester/Polystyrene Caps	£1.00
VP10	60	C280 Caps. Metal Foil Mixed	£1.00
VP11	50	Electrolytics – All Sorts	£1.00
VP12	40	Electrolytics .47mf-150mf Mixed Vlts	£1.00
VP13	30	Electrolytics 150mf-1000mf Mixed Vlts	£1.00
VP14	50	Silver Mica Caps. Mixed Values	£1.00
VP15	25	.01/250v Min Layer Metal Caps.	£1.00
VP16	50	Wirewound Res. Mixed Wand Values	£1.00
VP17	50	Metres PVC Single Strand Wire Mixed Cols	£1.00
VP18	30	Metres PVC Multi Strand Wire Mixed Cols	£1.00
VP19	40	Metres PVC Single/Multi Strand Wire	£1.00
VP20	6	Rocker Switches 2a 240V	£1.00
VP21	10	Assorted Switches Slider/Push Etc	£1.00
VP22	200	Sq Inches Total Copper Clad Board	£1.00
VP23	10	40mm Slider Pots. 100K Lin	£1.00
VP24	10	.125" Clear Showing Red LED's	£1.00
VP25	10	Mixed Shape and Colours LED's	£1.00
VP26	15	Small .125" Red LED's	£1.00
VP27	15	Large .2" Red LED's	£1.00
VP28	10	Rectangular .2" Red LED's	£1.00
VP29	30	Asst Vlts Zeners 250mw-2w	£1.00
VP30	10	Asst Volts 10w Zeners Coded	£1.00
VP31	10	5a SCR's T066 50-400v Coded	£1.00
VP32	20	3a SCR's T066 Up to 400v Uncoded	£1.00
VP33	200	Sil. Diodes Like IN4148	£1.00
VP34	200	Sil. Diodes Like 0A200/BAX13/16	£1.00
VP35	50	1a IN4000 Diodes All Good Uncoded	£1.00
VP36	100	Sq Inches Total Copper FibreGlass Board	£1.00
VP37	8	Black Pointer Knobs ¼w Std	£1.00
VP38	100	Sil. Trans NPN Plastic Coded Data	£3.00
VP39	100	Sil. Trans PNP Plastic Coded Data	£3.00
VP40	40	TTL I.C.s All New Gates – Flip Flop – MSI Data	£4.00
VP41	40	CMOS I.C.s All New Inc Data	£4.00
VP42	10	Black Heatsinks Fit T0-3 T0-220 Drilled	£1.00
VP43	4	Power-Fin Heatsinks 2 X T0-3 2 X T0-66	£1.00
VP44	15	Asst Heatsinks T0-1-3-5-18-220	£1.00
VP45	50	BC107/8 NPN Transistors Good Uncoded	£1.00
VP46	50	BC177/8 PNP Transistors Good Uncoded	£1.00
VP47	10	Sil. Power Trans. Similar 2N3055 Uncoded	£1.00

Pak No	Qty	Description		Price
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VP49	30	Asst Sil. Rects. 1a-10a Mixed Vlts		£1.00
VP50	60	NPN Sil. Switching Trans T0-18 - T0-92		£1.00
VP51	60	PNP Sil. Switching Trans T0-18 - T0-92		£1.00
VP52	25	Asst Audio Plugs Phono-Din-Jack Etc		£1.50
VP53	25	Asst Audio Skts Phono-Din-Jack Etc		£1.50
VP54	20	Asst I.C. Dil Skts 8-40 Pin		£2.50
VP55	10	I.C.s 4116 Memory's		£2.00
VP56	100	Semiconductors From Around the World		£4.00
VP57	25	Opto Special Pack. Assorted		£5.00
VP58	10	Hybrid LED Colour Displays		£4.00
VP59	20	Asst. I.C.s Coded, Linear, Etc		£2.00
VP60	100	All Sorts Transistors NPN/PNP		£1.00
VP150	20	BC183B Sil. Trans. NPN 30v 200mA Hfe240+	T092	£1.00
VP151	25	BC171B Sil. Trans. NPN 45v 100mA Hfe240+	T092	£1.00
VP152	15	TIS90 Sil. Trans. NPN 40v 400mA Hfe100+	T092	£1.00
VP153	15	TIS91 Sil. Trans. PNP 40v 400mA Hfe100+	T092	£1.00
VP154	15	MPSA56 Sil. Trans. PNP 80v 800mA Hfe50+	T092	£1.00
VP155	20	BF595 Sil. Trans. NPN Eqvt.BF184 H.F.	T092	£1.00
VP156	20	BF495 Sil. Trans. NPN Eqvt.BF173 H.F.	T092	£1.00
VP157	15	ZTX500 Series Sil. Trans. PNP Plastic		£1.00
VP158	15	ZTX107 Sil. Trans. NPN eqvt.BC107 Plastic		£1.00
VP159	15	ZTX108 Sil. Trans. NPN eqvt.BC108 Plastic		£1.00
VP160	20	E5024 Sil. Trans. PNP eqvt.BC214L	T092	£1.00
VP161	25	BC183L Sil. Trans. NPN 30v 200mA	T092	£1.00
VP168	10	BC478 eqvt. BCY71 PNP Sil. Trans.	T018	£1.00
VP169	10	BXS21 eqvt. BC394 NPN Sil. Trans. 80v 50mA	T018	£1.00
VP170	10	Assorted Power Trans. NPN/PNP Coded & Data		£1.00
VP171	10	BF355 NPN T0-39 Sil. Trans. eqvt.BF258 225v 100mA		£1.00
VP172	10	SM1502 PNP T039 Sil. Trans. 100v 100mA Hfe100+		£1.00
VP173	150	De-soldered Silicon Trans from boards all good		£1.00

LED DISPLAYS

VP130	6	RED 7 Seg. CC 14mm × 7.5mm RDP	FND353	£2.00
VP131	4	GREEN 7 Seg. CA .6" LDP	XAN6520	£2.00
VP132	5	RED 7 Seg. CC .6" LDP	XAN6940	£2.00
VP133	6	RED Over-flow .6" 3 × CA 3 × CC	6630/50	£2.00
VP134	5	GREEN Over-flow .6" CA	XAN6530	£2.00
VP135	5	RED 7 Seg. CA .3"	XAN3061	£2.00
VP136	3	DUAL RED 7 Seg. .5" CA DL527 DPR		£2.00
VP137	3	DUAL RED 7 Seg. .51" CA DL727 DPR		£2.00
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CC = Common Cathode
CA = Common Anode
RDP = Right Hand Decimal Point
LDP = Left Hand Decimal Point

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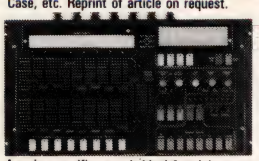

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VISA

STE-BUS POWER SUPPLY

BY FARIBA SANIEENEJAD

An STE compatible PSU with extra features including battery back-up and variable o/p

The STEbus power supply requirements are: +5V, ±12V, 0V and Vstby. Current limits are not dictated in the standard, but are left to user requirements. Since the bus is designed to facilitate logic-based cards and modules, the 5V rail will cater for the greatest current demand.

The dual 12V supply will probably be used for analogue circuits and the stand-by rail for low current back up of static RAM. In addition to the specified power rails, in this design, to cater for EPROM programming, an additional variable voltage supply is available. The specifications of the p.s.u. are shown in Table 1.

Table 1. *P.s.u. specifications*

	I_{max}	V_{out}	Regulation
5V	2A	5V	10mV
+12V	200mA	+12V	0·4%
−12V	200mA	−12V	0·4%
V_{stby}	100mA	5V	0·2%
V_{pgm}	100mA	2V–24V	0·1%

DESIGN CONSIDERATIONS

Whilst many of the commercially available p.s.u.s for the STEbus may be of advanced technical design (often switch mode operation), the emphasis in this project lies in simplicity and reliability. Voltage regulation is achieved through the use of standard, readily available components.

As the unit is designed, primarily, to power microprocessor based circuits, a toroidal transformer was used, which offers low noise and EMI characteristics, and obvious size advantages. The cost of these devices is almost down to that of traditional transformers.

The PE P1000 Standard constructional series is based around a 19 inch Eurocard sub-rack system which is available from a number of suppliers. However, it is not absolutely necessary to use this system, as a simple back plane and separate p.s.u. will do the job, but at the expense of a professional finish. If the sub-rack system is adopted, then this project will fit, snugly, into a 20E Eurocard module, giving an extremely neat appearance. The sub-rack system and slide-in module is shown in Photo 1 (part assembled) and Photo 2 (assembled). In both, the back plane is not shown. More will be said about Eurocards and sub-racks in Part 2, next month.

CIRCUIT OPERATION

Fig. 1. shows the complete circuit diagram of the P1000 Standard Power Supply Unit. T1 is fed from the mains via a two pole, on/off switch which may be used to power down the system. The secondary winding of T1 is centre tapped to provide 18V RMS + 18V RMS via a semi delay 3A fuse. A semi delay type was used to allow for current surges on power up.

REC1, rectifies the low voltage a.c. to give approximately 36 × 1·41V (RMS conversion factor ≈1·41) peak to peak. This is equivalent to plus and minus 25·5V peak with respect to the centre tap, 0V. C1–C3 provides smoothing giving an unregulated d.c. supply with a small (hopefully) ripple content depending upon the current demand of the unit.

The ±12V supplies are straight forward in their operation, relying simply on IC3 and IC5, 78 and 79 series regulators. Although these devices are capable of supplying up to about 1A, with suitable heat sinks, the ±12V supply in this design, is only intended to supply around 200mA. Keeping to this limit, no heat sinks are required as the maximum power developed in them will be about 2·8W, which is well within their dissipation capabilities.

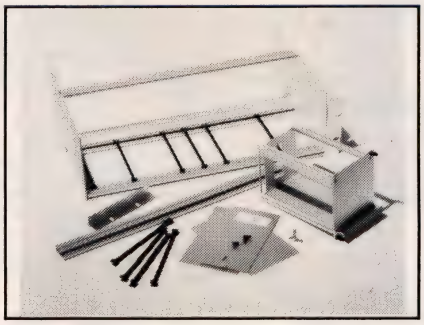


Photo 1. *19 inch rack assembly (part assembled)*

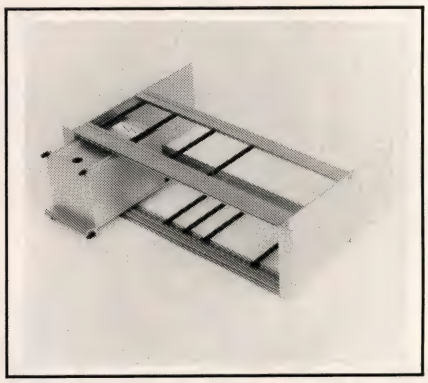


Photo 2. *19 inch rack assembly and module*

As said previously, most of the current taken from the supply will pass through the 5V regulator. To reduce the power requirement of this device, it is fed via a 3·3Ω, 17W resistor, R3. As more current flows through the regulator and thus the resistor, the potential across IC1 decreases thereby limiting the power developed.

Also to keep the temperature of the regulator down to an acceptable level, a 5°C/W heat sink is used. IC1 is internally protected but as an added precaution to protect both the p.s.u. and the load, a 2A fuse is included in the output.

PROGRAMMING AND STANDBY VOLTAGES

An adjustable 'programming' voltage (2–24V) is supplied via IC4, an LM317L variable voltage regulator which is capable of supplying up to 100mA. The output is adjusted by VR2 and is given by:

$$V_{out} = 1{\cdot}25\ (1 + VR2/R8)$$

The Vpgm voltage should be preset to the required level for a specific purpose, such as 21V for certain types of EPROM.

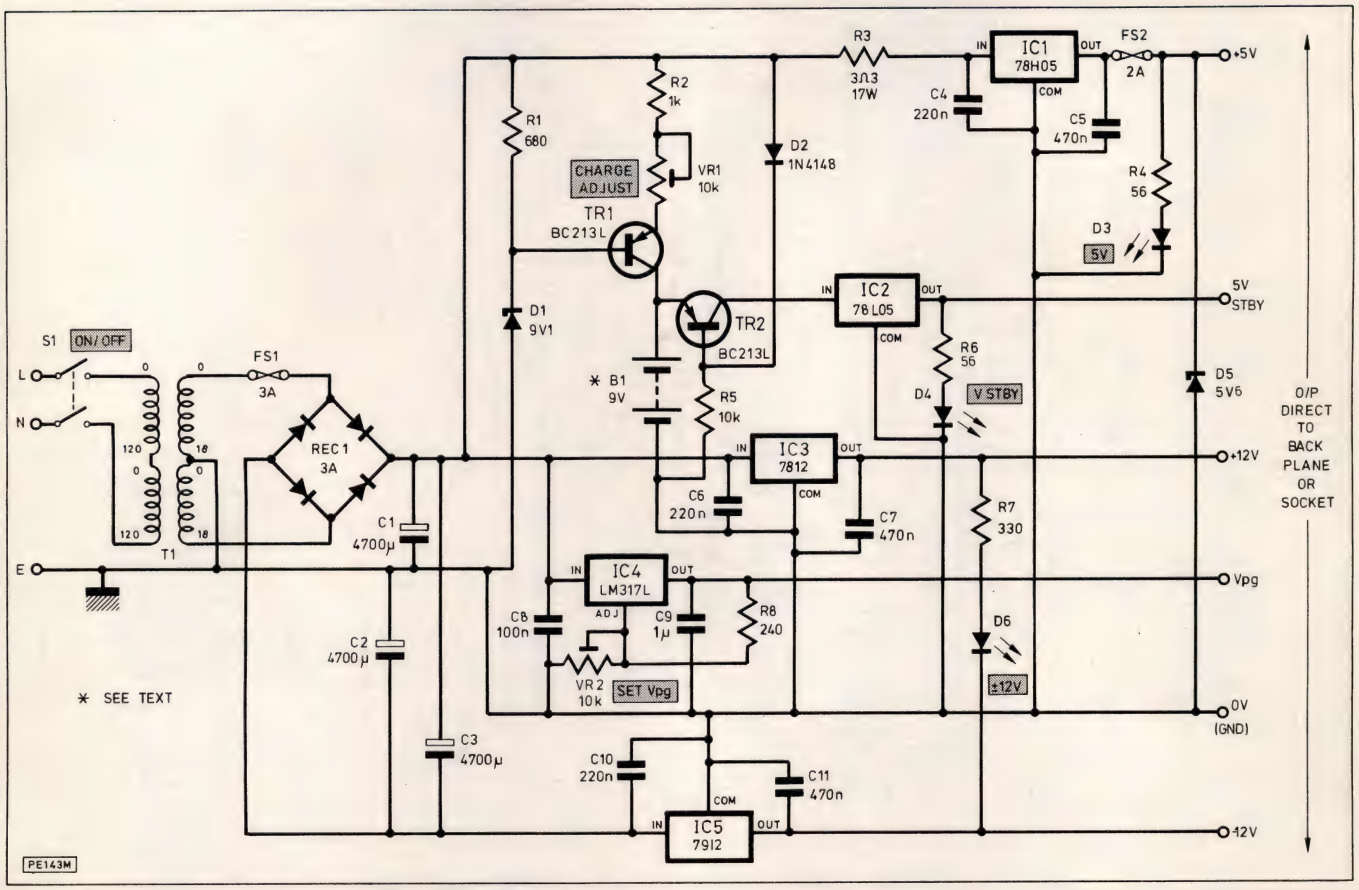


Fig. 1. *Complete circuit diagram of the PE STEbus p.s.u.*

COMPONENTS . . .

RESISTORS

R1	680
R2	100
R3	3Ω3 17W
R4,R6	56 (2 off)
R5	10k
R7	330
R8	240

All ¼W unless stated otherwise

POTENTIOMETERS

VR1	1k min trimmer
VR2	10k min trimmer

CAPACITORS

C1,C2	4700µ 25V elect. (2 off)
C3	4700µ 63V elect.
C4,C6,C10	220n Polyester (3 off)
C5,C7, C11	470n Polyester (3 off)
C8	100n Polyester
C9	1µ Polyester

SEMICONDUCTORS

D1	9V1 Zener 500mW
D2	1N4148
D3,D4,D6	Low current l.e.d. (3 off)
D5	5V6 Zener 5W
REC 1	3A Bridge rectifier (in-line)
TR1,TR2	BC213 (2 off)
IC1	78H05 Voltage regulator
IC2	78L05 Voltage regulator
IC3	7812 Voltage regulator
IC4	LM317L Voltage regulator
IC5	7912 Voltage regulator

MISCELLANEOUS

T1, transformer 18V + 18V secondary 2·78A toroidal; S1, 2-pole mains on/off switch; FS1, 3A 20mm fuse and p.c.b. mounting fuse clips; FS2, 2A 20mm fuse and clips; B1, 9V Ni-Cad PP3 batery and holder; capacitor horizontal mounting clip; TO3 heat sink, 5 deg C/W; P.c.b., PE 864–02 available from the PE P.c.b. Service; high voltage warning label; wire, cable, solder, etc.

EUROCARD MODULE DETAILS

Eurocard module 3U, 20E with fittings
Eurocard module screening kit 3U, 20E
24-way module plug and connector mounting plate

EUROCARD SUB-RACK

Sub-rack 19 inch 3U with fittings
160mm module guides
24-way module socket

It is likely that, at some time, the p.s.u. will be required to supply volatile memory devices whose contents are important. Under these circumstances, it is wise to arrange a back-up supply should the mains fail. In this design, a 5V standby supply is available from a Ni-Cad battery and a low power regulator, IC2.

When power is supplied to the board via T1, the base-emitter junction of TR2 is in reverse bias due to the current through D2 and R5. Under these conditions, B1 cannot supply current to IC2. Should the supply be switched off or inadvertently disconnected, C1 will discharge. When the voltage across C1 falls to approx. 8V, TR2 will conduct and IC2 will provide stand-by current.

CHARGING

A Ni-Cad battery was chosen for back-up as it can be automatically charged when power is supplied to the p.s.u., i.e., in normal use. The maximum constant charge rate for B1 is quoted as 1·1mA. This can be preset via VR1 and checked using a multimeter.

VR1, D1, R2 and TR1 form a constant current source. As current passes through R2 and VR1, the voltage present at the emitter of TR1 will fall. When this falls to around 10V, TR1 will be in reverse bias and the

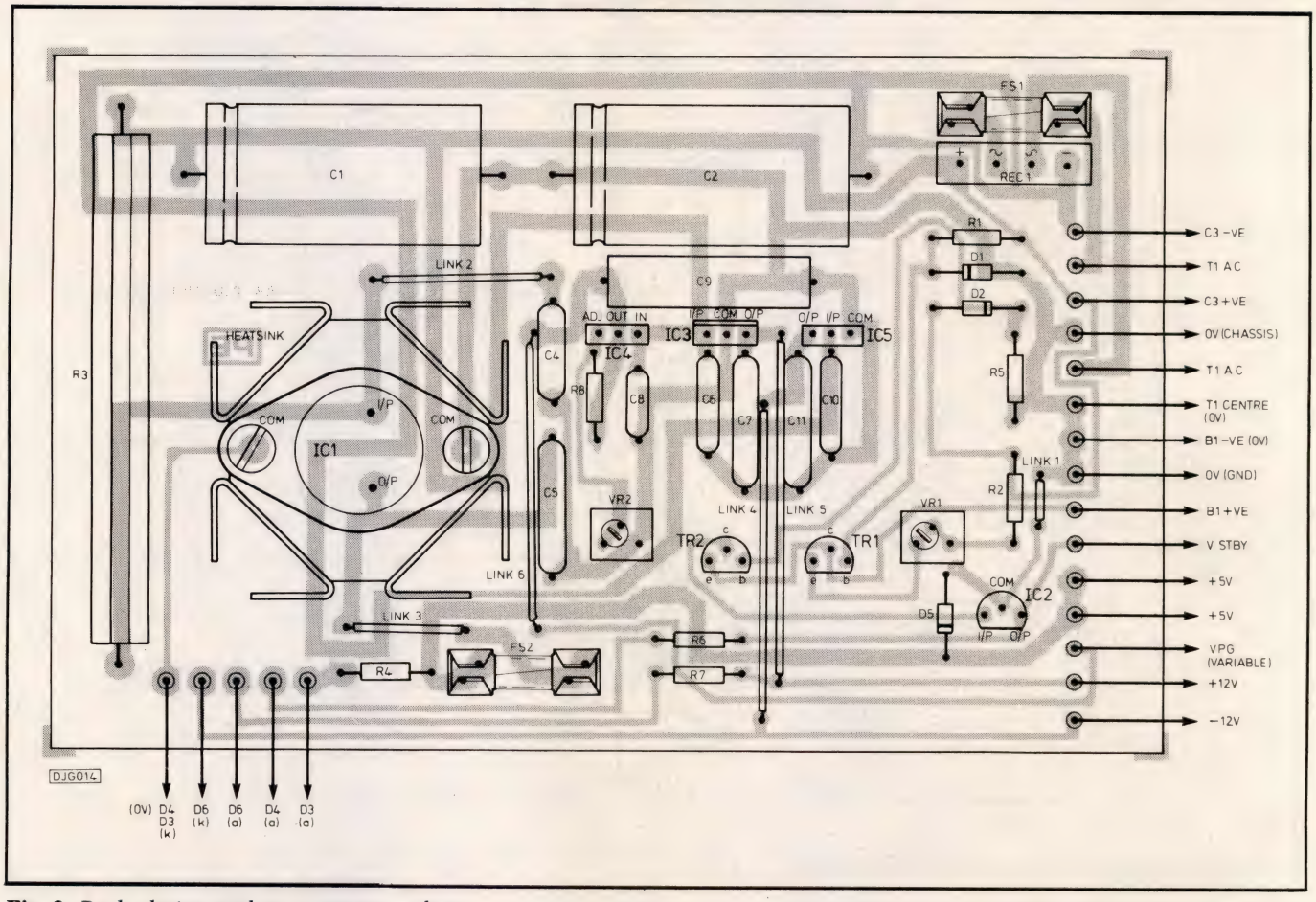


Fig. 2. *P.c.b. design and component overlay*

current through R2 and VR1 will fall. In this way, the current will find a natural level, dependent on the setting of VR1. If battery back-up is not required, simply disconnect B1.

D3, D4 and D6 are low current l.e.d.s which act as supervisory indicators. Under normal conditions, D3 and D6 should be illuminated and under mains failure, D4 should light. If either of the 12V rails fail, D6 will be unlit but D3 should remain illuminated.

CONSTRUCTION

The p.c.b. design and component layout is shown in Fig. 2. Construction and assembly should be fairly simple, but good workmanship is essential if errors and faults are to be avoided. Before mounting any of the components, drill the required holes for IC1. Smaller components such as resistors (not R3) should be mounted first, followed by the transistors, regulators (not IC1) and pre-sets.

The smaller capacitors (non-electrolytic) should be mounted next, followed by C1 to C3 and R3. Lastly, IC1 should be mounted. This component should be carefully positioned (with heat sink compound) together with the heat sink over its mounting holes, making sure that the input and output connections do not touch the heat sink.

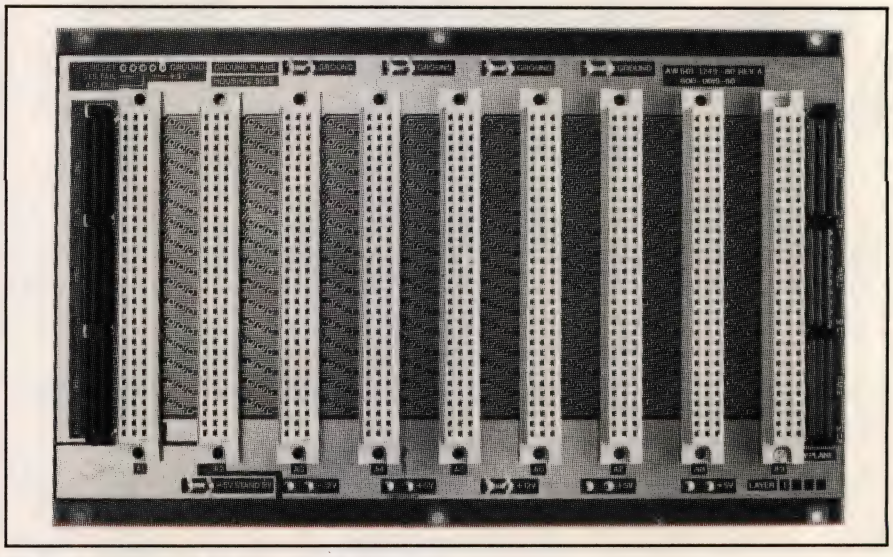


Photo 3. *A typical STEbus backplane*

The i.c. should then be bolted down and soldered in place. Note, that in this design, the case of IC1 is used as a ground connection for D3 and D4 cathodes, so it is essential that metal nuts and bolts are used, making good contact with the p.c.b. tracks.

HOUSING

If the p.s.u. is not being used as part of the PE IEEE P1000 system, or not being module mounted, then the board together with C3, B1, T1 and S1 may be fitted into any suitable case. However, if a Eurocard module is to be used, as it probably is, then mounting details are critical.

NEXT MONTH, this series continues with details of the rack system, STEbus back plane and final constructional details of the p.s.u.

BBC MICRO FORUM

BY RAY STUART

This month, Forum takes a look at the circuitry behind the 1MHz bus

Most computers allow user access to the main address, data and control buses via some form of interface and the BBC microcomputer is no exception. The interface in this case is called the 1MHz bus and provides the user with a powerful yet easily used method of expanding the system. It is this interface that will be discussed in this month's BBC Micro Forum.

1MHz BUS

The 6502 CPU used in the BBC microcomputer is designed to run at 2MHz when accessing its own memory. However, a number of peripheral devices, such as VIAs, will not function correctly at this speed and therefore require a lower clock rate. The BBC microcomputer allows such devices to be used via this bus by adjusting the clock frequency to 1MHz whenever it is accessed; hence the name of the bus.

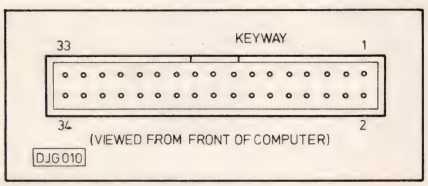


Fig. 1. *IDC connections*

Connection to the bus is by means of a 34-way IDC ribbon cable connector as shown in Fig. 1. Reference to the pin functions in Table 1 shows that the bus consists of eight data lines, eight address lines, seven control lines and an analogue input which allow access to the computer's audio circuit.

At first sight the provision of only eight address lines would appear to somewhat limit the usefulness of the bus by allowing only 256 bytes of memory to be accessed. However, this is far from the truth as it can be used to address an extra 64K bytes of external memory. The mechanism that allows this will be explained later.

CIRCUIT DESCRIPTION

A schematic of the bus circuitry is shown in Fig. 2. The BBC microcomputer's internal address and data bus is buffered before being directed to the output connector. A 74LS244 buffers the eight uni-directional address lines and a 74LS245 buffers the eight bi-directional data lines.

Table 1. *1MHz bus connector pin functions*

PIN	FUNCTION	PIN	FUNCTION
1	GND	18	D_0
2	R/$\overline{W}$	19	D_1
3	GND	20	D_2
4	1MHzE	21	D_3
5	GND	22	D_4
6	NNMI	23	D_5
7	GND	24	D_6
8	NIRQ	25	D_7
9	GND	26	GND
10	NPGFC	27	A_0
11	GND	28	A_1
12	NPGFD	29	A_2
13	GND	30	A_3
14	NRST	31	A_4
15	GND	32	A_5
16	ANALOGUE IN (SOUND)	34	A_6
17	GND	34	A_7

The 6502 generates a R/$\overline{W}$ signal to inform the system if it is reading or writing data. This is also buffered and used to control the data direction input of the 74LS245 before being applied to the 1MHz bus connector. When power is applied to the BBC microcomputer, it generates a reset pulse, called NRST, that is used to synchronize the system. Most peripheral devices connected to the 1MHz bus may also have to be synchronized to the main system, for example when break is pressed, thus this signal is also provided on the 1MHz bus connector.

The 6502 CPU provides two interrupt lines, NNMI and NIRQ. These allow the current operation to be suspended and one of a higher priority to be undertaken. However, the interrupt routines are vectored via addresses stored in the computer's RAM. These are set when the system is initialised or when a ROM is called. Therefore if one wishes to use these interrupts one should do so with care otherwise the system may crash.

The 1MHz bus is allocated two pages in the BBC microcomputer's memory map, pages FC and FD. The main decode circuitry provides two control lines to indicate to the 1MHz bus when it wants to access it. They are designated NPGFC for address range &FC00–&FCFF, and NPGFD for address ranges &FD00–&FDFF. It will be noted that each signal therefore represents a range of 256 bytes. Acorn have chosen to call these address ranges by the two names FRED and JIM, where FRED = NPGFC and JIM = NPGFD.

CLEAN FRED AND JIM SIGNALS

Normally the BBC microcomputer's 6502 CPU runs at 2MHz. However, when the 1MHz bus is addressed, the system changes the clock to 1MHz as stated above. This has the effect of producing "glitches" on the FRED and JIM select lines. It is possible that these glitches could cause the external hardware to believe that data is valid when in fact it is not. Thus spurious data could be transferred across the 1MHz

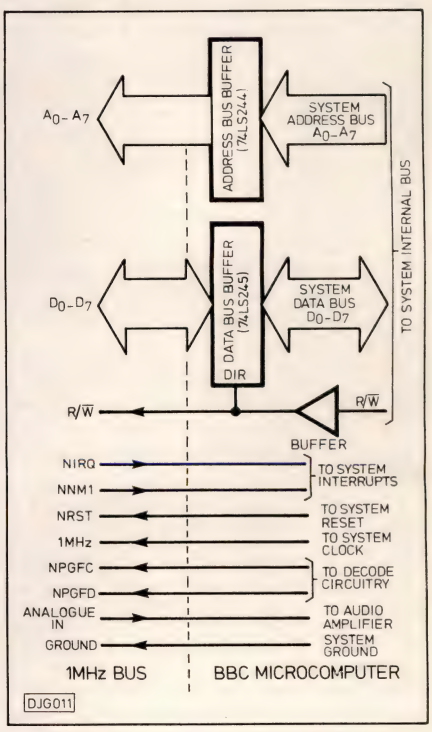


Fig. 2. *Bus circuitry*

Table 2. *Fred memory map (Acorn)*

ADDRESS	ALLOCATION
FC00–FC0F	TEST HARDWARE
FC10–FC13	TELETEXT
FC14–FC1F	PRESTEL
FC20–FC27	IEEE 488
FC30–FC3F	CAMBRIDGE RING
FC80–FC8F	TEST HARDWARE
FCC0–FCFE	USER APPLICATIONS
FCFF	EXTENDED PAGE REGISTER

bus. Obviously this state of affairs cannot be allowed and is easily overcome by using the circuit shown in Fig. 3. This circuit is implemented using a single 74LS02 and although it does not remove every glitch, for most applications, it allows correct operation.

FRED

It is allowable for more than one external unit to be connected to the 1MHz bus at the same time. Should they both occupy the same address range, e.g. &FC00–&FC0F, they would both attempt to send data to the data bus thereby causing it to crash. Acorn have therefore allocated specific areas of FRED for specific applications. These include Acorn's own Teletext, Prestel and IEEE interfaces, and their memory allocations are shown in Table 2.

It will be noticed that this allocation provides the user with only 63 bytes. This may appear to severely limit the usefulness of the 1MHz bus. However, if one considers some of the peripheral interface chips available, then the actual number of input/output lines that can be provided is considerable. Take for example the Intel 8255. This chip provides three 8-bit ports, i.e. 24 input/output lines, yet only requires four memory locations. Thus some fifteen 8255 could be mapped into this area providing some 360 independent input/output lines. This should prove adequate for all but the most ambitious of applications.

If you are designing hardware peripherals for your own use then you are free to use whatever FRED or JIM memory locations you wish. However, if there is any possibility that other 1MHz bus peripherals could be used with the same BBC microcomputer or the peripheral is to be used by someone else, then the memory map specified by Acorn should be adhered to. This will prevent data bus conflicts and consequent system crashes. Once the software and peripheral address decoding has been designed, it is most frustrating to have to redesign it for future applications.

JIM AND THE PAGING REGISTER

The upper memory location in FRED is allocated for what is known as the Paging Register and it is this that allows the bus to address 64K bytes of memory with the aid of a hardware latch. Whenever this latch is addressed it stores whatever data is present on the data bus. If it is arranged for this data to represent the A_8–A_{15} address lines of a 16-bit address then it can be used in conjunction with the A_0–A_7 address lines of JIM to produce a 16-bit address, and hence access 64K bytes of memory. This extra memory is referred to as Extended Page Memory. Acorn have allocated certain address locations for specific applications as indicated in Table 3. Although 32K bytes are allocated for system use by Acorn, there are still 32K bytes available for user applications. Thus the 1MHz bus is far more powerful than first impressions would indicate.

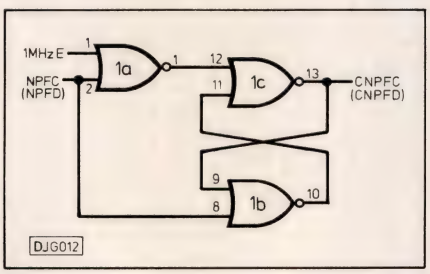


Fig. 3. *Clean-up circuit*

It is a condition of using the paging register that it be set to zero when the BBC microcomputer is switched on or when a keyboard break is issued. A suitable circuit for the paging register latch is shown in Fig. 4.

The 74LS133 is a 13-input NAND gate. Only when all its inputs are Logic 1 will its output be Logic 0. As three inputs are connected to +5V and the other eight inputs connected to FRED's address lines, the 1MHz signal and CNPGFC (via an invertor), the output will only be Logic 0 for address &FCFF. The data bus is applied to the input pins on the 74LS273, an eight bit latch. When the 74LS273's clock (pin 11) is taken to Logic 0 it latches the data present on its input pins. Thus the circuit stores the upper eight address lines of the extended page memory address.

The 74LS273 also has a clear input (pin 1) which when taken to Logic 0

Table 3. *Extended page memory map (Acorn)*

ADDRESS	ALLOCATION
0000-7FFF	SYSTEM
8000-FFFF	USER APPLICATIONS

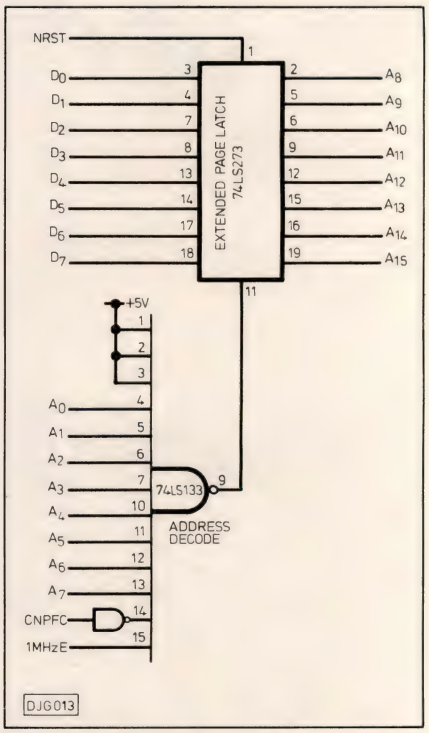


Fig. 4. *Paging register latch*

clears the latches so that the output is zero. The NRST line is therefore connected to this to implement the break condition mentioned above.

HARDWARE CONSIDERATIONS

Acorn have specified certain standards to which hardware connected to the 1MHz bus should conform. These are specified so that correct and reliable operation is ensured and they are discussed below.

The 1MHz bus lines should be loaded with no more than one LS TTL load. In practice this implies that for most peripherals the 1MHz bus should be buffered. Similar circuitry to that inside the BBC microcomputer can be used. A 74LS244 can be used for the address bus buffer and a 74LS245 used to buffer the data bus. The remainder of the signal lines, with the exception of the interrupt and the analogue lines can be buffered using a 74LS04.

All bus lines except NRST, NIRQ, NNMI should be terminated or have the provision to be terminated. The recommended termination is to connect these lines to +5V with a 2k2 resistor and to ground with a 2k2 resistor. The easiest method to achieve this is to use s.i.l. resistor packs.

The recommended method of connecting peripherals to the BBC microcomputer's 1MHz bus connector is via 34-way ribbon cable fitted with 34-way IDC connectors. The peripheral should provide an additional socket to allow further peripherals to be con-

nected to the 1MHz bus. The recommended length is 600mm, but longer cables have been used with some peripherals without loss of performance or reliability. In some cases several metres of cable have been used with no ill effects.

It is recommended that peripherals should be self powered, i.e. fitted with their own mains power supply. However, peripherals have been built that use the BBC microcomputer's own power supply without problems.

SOFTWARE CONSIDERATIONS

Driving the 1MHz bus is relatively easy as it can be regarded as a range of memory addresses and accessed by means of the indirect operator "?". For example data can be written to the 1MHz bus at, say, address &FC09 as follows: ?&FC09 = DATA. In a similar manner, to read the contents of the memory location one could use DATA = ?&FC09.

However the BBC microcomputer's operating system provides four OSBYTEs that are specifically designed to read/write data from/to the 1MHz bus. These are:

OSBYTE &92	read FRED
OSBYTE &93	write FRED
OSBYTE &94	read JIM
OSBYTE &95	write JIM

On entry, X should contain the offset from the start of the page (FRED or JIM), e.g. to read/write to address &FC46 X would contain &46 and the page would be FRED. For a write command, Y should contain the data byte to be written, and for a read operation, Y will contain the data byte read. Note the CALL address for OSBYTE is &FFF4.

Thus one can construct five modules, three procedures and two functions that can be used in programmes. The function command "FN" will always return a result and is therefore used to read from the 1MHz bus. These modules are shown in Program 1.

Program 1. *Simple 1MHz bus operation*

```
 10 REM *******************************************************
 20 REM *                                                     *
 30 REM *                BBC 1MHz Bus interface               *
 40 REM *                                                     *
 50 REM *            Ray Stuart     January 1985              *
 60 REM *                                                     *
 70 REM *******************************************************
 80
 90
100 DEFPROC_write_fred_(offset%,byte%)
110 X%=offset%:Y%=byte%:A%=&93:CALL &FFF4
120 ENDPROC
130
140
150 DEFPROC_write_jim_(offset%,byte%)
160 X%=offset%:Y%=byte%:A%=&95:CALL&FFF4
170 ENDPROC
180
190
200 DEFPROC_paging_register_(byte%)
210 X%=&FF:Y%=byte%:A%=&93:CALL &FFF4
220 ENDPROC
230
240
250 DEFFN_read_fred_(offset%)
260 LOCAL Z%
270 X%=offset%:A%=&92:Z%=USR(&FFF4)
280 =(Z% AND &FF0000) DIV &10000
290
300
310 DEFFN_read_jim_(offset%)
320 LOCAL Z%
330 X%=offset%:A%=&94:Z%=USR(&FFF4)
340 =(Z% AND &FF0000) DIV &10000
```

First let us consider the write procedures for FRED, JIM and the Paging register. All three procedures are similar and use the same variable names. The variable "offset%" is the lower byte of the address to be accessed and the variable "byte%" is the value to be written to the address. The "offset%" variable is not required for PROC_paging_register as it is fixed at &FF. For example "offset%" would be &56 if the address were &FC56. Note this is sometimes also referred to as FRED &56. Thus to write &34 into address &FC89 (FRED&89) use

PROC_write_fred_(&98,&34)

The two functions are also similar and as with the procedures use the same variables.

The variable "offset%" refers to the lower address byte "Z%" representing the returned value. However, this value is returned as a four byte value with the third most significant byte being the valve we require. The returned value is thus ANDed with &FF0000 to set the unwanted bytes to zero and DIVed by &10000 to produce the required single byte. PE

BOOKS FOR THE BBC

BEGINNERS GUIDE TO INTERFACING THE BBC MICROCOMPUTER

Martin Philips—Macmillan. ISBN 0-333-38652-3 170 pages paperback. £6.95

As the title suggests, this book is for beginners. Some prior knowledge of programming is required but only a basic understanding of physics is needed to get to grips with the electronics.

The first few chapters introduce simple electronic principles and familiarise the reader with the BBC user and digital ports. Following chapters deal with various home interface projects, each one described in detail and backed by substantial software listings.

A useful appendix section is included which contains three fully explained programs for: calculating values, interpreting resistor colour codes and designing the user port.

R.M.B.

THE TRANSDUCER PROJECT BOOK

Michael J. Andrews—Tab Books Inc. ISBN 0-8306-1992-5 130 pages paperback. £7.95

The Transducer Project Book is suited to the beginner. There is a minimal amount of electronics involved with each project but the principles which are used, are fully explained at each stage.

Transducers, nowadays, are often associated with computers. Most of the projects in this book can be built and used without the need for computer interfacing or indeed a computer. Only a small section is devoted to computer applications.

Projects described include: digital yardstick, sound activated switch, electronic balance, frequency meter and a temperature controlled crystal oven.

F.R.S.

BYTEBOX UPDATE

Modifications and further design ideas for the Bytebox

The Bytebox project published in October–November 1985 is probably the most popular of recent PE projects. It has stimulated a great deal of response from readers who intend to, or have built it—most with success. From this response, we have learnt of a few modifications which may be of further interest to Bytebox owners.

UPDATE ONE

By J. R. KELLY

In successfully completing the Bytebox I experienced a few problems which I thought should be brought to your attention.

1. The EPROM circuit board (009) needs a shorting link between pins 27 and 28 on IC 302 to conform with the circuit diagram. Otherwise the computer will not necessarily access the lower 8K of the ROM.

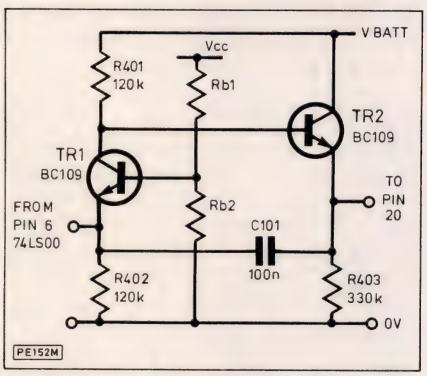


Fig. 1. *Using positive feedback*

2. The battery backed RAM circuit does not always work effectively. At least mine did not.

The frequency response of the BC 109 is quoted in the catalogues as 300MHz in common base mode. In common emitter, as in the published circuit, the frequency response is roughly this figure divided by the current gain, which with a low gain device gives about 2MHz at best. The transistors in the circuit are expected to pass pulses of one half microsecond width, but since they are connected in common emitter without feedback this is not possible. Inspection with an oscilloscope confirmed this. The pulses were present at pin 6 of the 74LS00 but were not getting through the transistors. By putting speedup capacitors across R203 and R205 a rudimentary pulse appeared but nothing like good enough to operate the system. The circuit of Fig. 1, using a common base input stage followed by an emitter follower output with overall a.c. positive feedback, works very well.

With the computer switched off, TR1 is unbiased and not conducting and TR2 adds about 10 microamps to the battery drain. From Mr Stuart's figures this should give a battery life of 80 days instead of 100 days.

In the course of developing this circuit I had redesigned the battery charging circuit and, to reduce biasing problems, used it to run the 74LS00 from the battery voltage. The complete circuit is shown in Fig. 2 complete with the new components.

As the battery voltage falls, the bias voltage on TR3 increases and more charging current is supplied. The diode can be any small signal general purpose silicon type and the transistors used were plastic BC 107s although almost any small signal type would do.

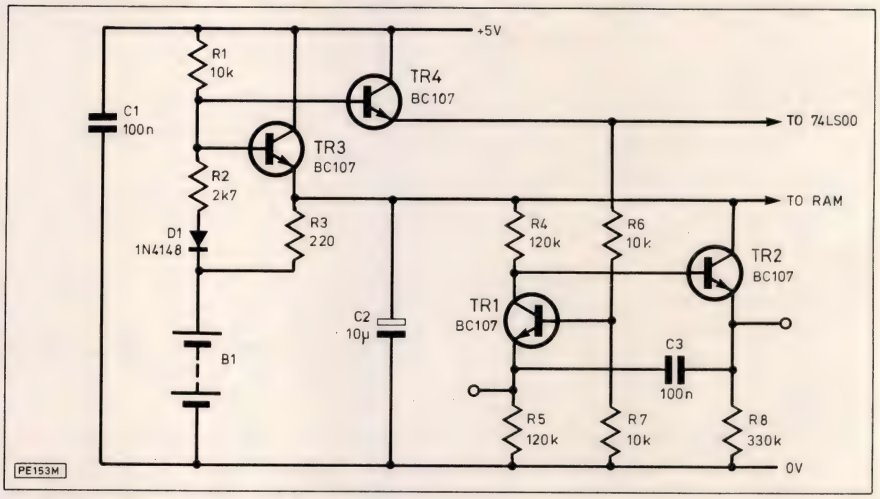


Fig. 2. *Battery charging circuit changes*

The bias for TR1 must be low impedance since it is in common base mode but if a decoupling capacitor is used in the conventional fashion then a time delay is introduced and the first few bytes from &8000 do not get programmed. By keeping the bias purely resistive this problem was overcome, which is why the bias resistors are lower than normal.

If the original charging circuit is used then Rb1 should be 18K and Rb2 10k. The whole circuit is on a piece of

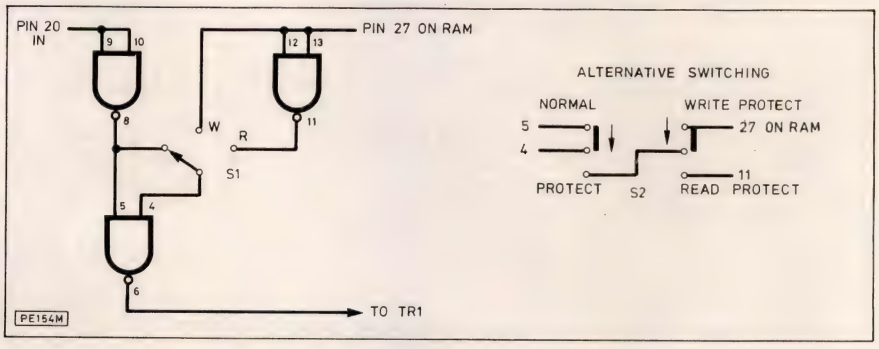


Fig. 3. *Read protect facility using rehashed logic*

Veroboard 1·5 by 0·8 inches supported at the side of the original board by its connecting wires.

3. By rehashing the logic I have provided a read protect facility as well as a write protect with only three of the gates in the 74LS00.

Pin 27 is controlled by the R/W output of the 6502 and is at logic 0 for a write and logic 1 for a read operation. A logic 0 on pin 4 will force a logic 1 on pin 6, deselecting the RAM. By inverting the read signal and applying it to pin 4 the chip is deselected during a read operation but can still be written to, thus enabling you to regain keyboard control and flush out the RAM after what might have otherwise been a catastrophic crash.

UPDATE TWO

By RAY STUART

I do not agree with all of Mr Kelly's comments. The prototype battery backed RAM board did work. I have, however, heard that some people have experienced problems. Whilst I think that Mr. Kelly's circuit will work (I have not tried it myself), I would like to offer my solution which is even simpler than the original circuit. This is shown in Fig. 4.

Mr. Kelly's modification to the write protect circuit is amusing, but I cannot think why one might want a read protected RAM, unless it's his vision of a black hole!

There is another simple addition that has proved useful to me which I think will be of interest to others. When developing some software to run from sideways ROM, it is useful to test it in sideway RAM before committing it to ROM. Should one get the software wrong and effectively put rubbish into the RAM the system can see this as commands, and crash. Once this happens it is impossible to clear by switching off as it is battery backed. The only way of clearing the rubbish is to remove the card. Obviously this is annoying. The addition I suggest is to fit a second switch to allow the battery to be disconnected and the RAM to be powered by the BBC's +5V line directly. This addition is detailed in Fig. 4. PE

Constructors' Note

A complete kit of parts for the Bytebox is available from: Peripheral Projects, 25 Braycourt Ave, Walton-on-Thames, Surrey.

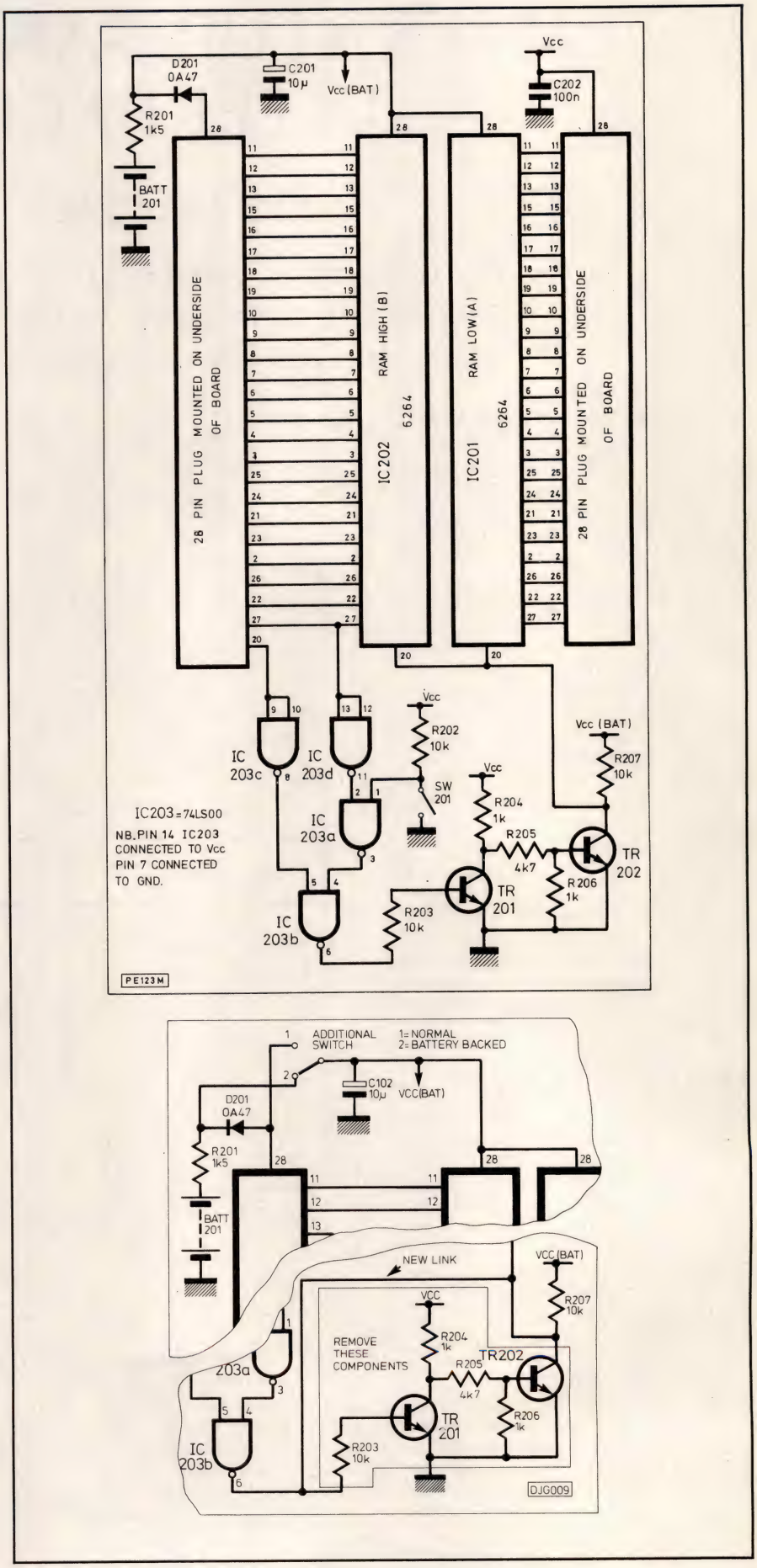


Fig. 4. *Author's solution and original circuit*

TEMPERATURE-ANALOGUE INTERFACE

BY R. A. PENFOLD

Two-channel temperature interface plus dual analogue ports for the Amstrad and the Spectrum

THIS interface was designed to give the Amstrad CPC464 computer four analogue inputs, two of which are intended for use with semiconductor temperature sensors to give a measuring range of 0 to 51 degrees Centigrade with 0·2 degree resolution. However, the unit can be used as a straightforward four channel analogue to digital converter if desired.

Although the unit was not designed with the Spectrum computer in mind, it has been tried with this computer and worked perfectly well. The only modification required for use with the Spectrum is the use of a different edge connector.

The two analogue inputs have a full scale sensitivity of 1·2V and can be used together to provide a single differential input. If the inputs for the two temperature sensors are used as ordinary analogue inputs they have a full scale value which is adjustable from about 350mV to 1·2V. The sensitivity of each channel is individually adjustable. All four channels offer an accuracy of plus and minus 1 l.s.b.

SYSTEM OPERATION

A circuit of this type could be quite complex, but in this case things are kept remarkably simple by using a modern four-channel analogue to digital converter chip (the ADC0844CCN) and an equally modern temperature sensor chip (the LM35DZ). Fig. 1 shows the block diagram for the interface, and several of these blocks represent the internal circuit of the ADC0844CCN.

At the heart of the unit is the single successive approximation converter of the ADC0844CCN. The way in which this type of converter functions has been described in previous articles in this magazine, and we will not consider this aspect of the unit in detail here. While not providing ultra-fast conversions, the successive approximation technique is reasonably fast and can be achieved by a relatively low cost device. In the case of the ADC0844CCN the conversion time is no more than 40µs, and at 25 degrees Centigrade is typically 30µs. This enables up to about 25000 conversions per second to be achieved, which is more than adequate for the vast majority of applications. The reason for the exact conversion time being temperature dependent is that the ADC0844CCN has a built in clock oscillator which includes on chip timing components. The lack of frequency stability that this inevitably produces is of little practical importance, and it helps to minimise the number of discrete components that are needed.

A four-channel analogue multiplexer ahead of the converter provides the unit with its four input channels. This is not as good as having four separate converters as each channel in use has to be read in turn. With all four channels in use this enables each channel to be read only about 6000 times or so per second, but even this reduced rate is far higher than is required for most applications.

The required channel is selected by writing data to the converter, but only the four least significant bits are utilized when doing this. The data is stored in a four-bit latch, and in addition to selecting the channel to be converted it also sets the operating mode of the device and initiates a conversion. There are three operating modes, and these are single ended, differential, and pseudo differential. The single ended mode is the normal one where each input responds to the input voltage relative to the earth rail. In the differential mode the converter becomes a two-channel type with one pair of input voltages applied to chan-

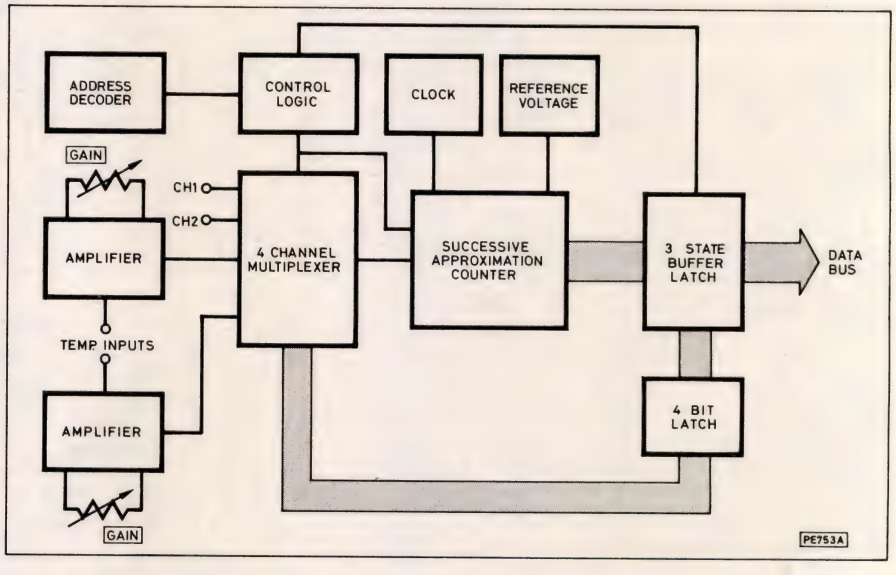


Fig. 1. *Block diagram*

Unlike many analogue to digital converter chips, the ADC0844CCN does not include an internal reference voltage source. The full scale value of the converter is equal to the reference voltage used, and this can be any voltage of 5V or less. In the interest of good linearity it is not advisable to use a reference potential of much less than about 1V though. In this circuit a highly stable 1·2V reference source is utilized.

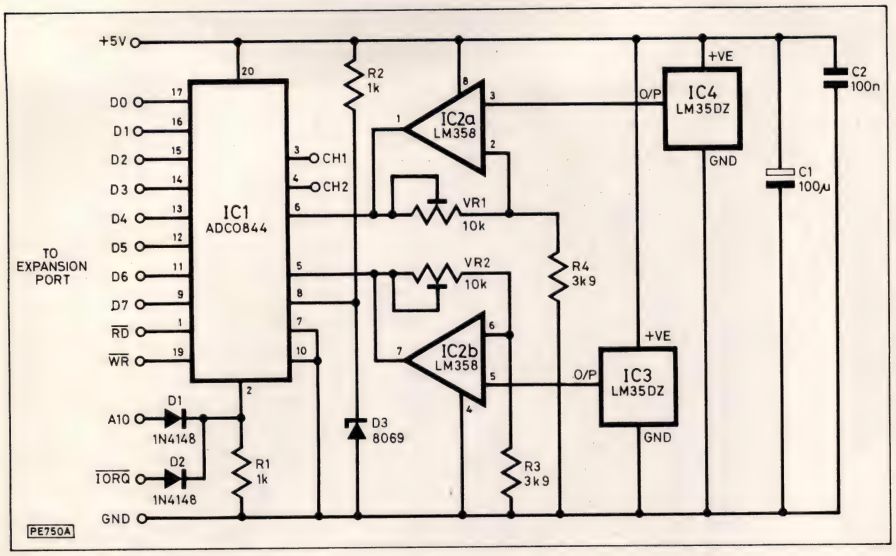


Fig. 2. *Complete circuit diagram*

nels 1 and 2, and the other two applied to channels 3 and 4. In the pseudo differential mode the unit is reduced to three channels (1, 2, and 3) with channel 4 being used as the inverting input for all three channels. This mode is not really applicable in this case due to the amplifiers added ahead of the channel 3 and channel 4 inputs.

When a conversion has been completed the result is stored in an eight-bit data latch which has three state outputs. The outputs of the latch can therefore be connected direct to the data bus of the computer. Although the converter has four channels it only occupies one address, and the channel read at that address is the one previously selected by a write operation. Even if the same channel is read each time, a write operation must precede the taking of each reading in order to initiate fresh conversions. Otherwise the same conversion would be read repeatedly.

The address decoder is extremely simple, and only decodes one address line plus one control line. This is made possible by the simple system of input/output mapping used in the CPC464 and Spectrum computers, plus the fact that the ADC0844CCN is specifically intended to interface with 8080/Z80 based systems, and has inputs for the $\overline{RD}$ (read) and $\overline{WR}$ (write) lines.

TEMPERATURE SENSOR

There are normally difficulties if a semiconductor temperature sensor is connected direct to the input of an analogue to digital converter without using some form of signal conditioning circuit. For example, the popular LM335Z provides an output of 10mV per degree Kelvin, or 2·73V plus 10mV per degree Centigrade in other words. A temperature range of (say) 0 to 50 degrees Centigrade therefore gives an output voltage range of 2·73V to 3·23V. Obviously the output of the sensor could be fed to an analogue input having a full scale value of 3·23V, but this would be a very inefficient way of doing things since input voltages from 0V to 2·73V would never occur, and most of the converter's input range would be wasted. This is not merely of academic importance, and in practice would result in the system having relatively poor resolution and accuracy.

Much better results could be obtained using a signal conditioning circuit to remove the 2·73V offset, and to spread out the 0 to 50 degree range over the full input voltage range of the converter. This type of manipulation is rendered unnecessary by the LM35DZ temperature sensors used in this design. These have a built-in circuit to eliminate the offset voltage, so that the output voltage is nominally 10mV per degree Centigrade. This gives a 0 to 510mV output voltage range over the 0 to 51 degrees Centigrade temperature span covered in this case. A simple d.c. amplifier at each of the two temperature sensor inputs boosts this to a 0 to 1·2V range which fully drives the converter. The converter provides readings of 0 to 255, which conveniently converts to readings in degrees Centigrade simply by dividing returned values by five. The gain of both amplifiers has been made variable so that they can be set up for optimum accuracy.

It must be pointed out that at very low temperatures of only about 1 degree Centigrade the LM35DZ may not give good accuracy, but it will give good results over a range of 2 to 51 degrees Centigrade. In its favour it has the advantage of not requiring a highly stable supply, or even a stabilised supply for that matter, and it will operate over a 4 to 30 volt supply range. With a current consumption of only 56µA there is little self heating.

CIRCUIT OPERATION

The full circuit diagram of the interface appears in Fig. 2. D3 and R2 form a shunt regulator which provides the 1·2V reference for converter chip IC1. D3 is not an ordinary Zener diode, but is a highly accurate and temperature compensated regulator chip. IC2 provides the two amplifiers which are conventional operational amplifier non-inverting mode types. The LM358 is one of the few operational amplifiers that is capable of providing output voltages right down to the earth rail, and this renders a negative supply rail unnecessary. IC3 and IC4 are the two LM35DZ temperature sensors.

The unit connects to the floppy disc port of the CPC464 computer, which is really a general purpose expansion port having the full buses etc. available. The system of input/output mapping used in the CPC464 is to have circuits activated by taking one the eight most significant address lines low. One or more of the eight least significant address lines can be decoded as well if an input/output circuit requires several addresses (which is obviously not the case here). Address line A10 is available for external add-ons, and this line is decoded with the $\overline{IORQ}$ (input/output request) line and used to generate the negative chip select pulse for IC1. D1, D2, and R1 form a simple 2-input OR gate. The interface is placed at address &F800 in the

COMPONENTS . . .

RESISTORS

R1,R2	1k (2 off)
R3,R4	3k9 (2 off)
All ¼W 5% carbon	

POTENTIOMETERS

VR1,VR2	10k 0·1W horizontal preset (2 off)

CAPACITORS

C1	100µ 10V radial elect
C2	100n ceramic

SEMICONDUCTORS

D1,D2	1N4148 (2 off)
D3	8069
IC1	ADC0844CCN
IC2	LM358
IC3,IC4	LM35DZ (2 off)

MISCELLANEOUS

Case about 133 by 70 by 38mm; printed circuit board, PE 101; computer connector; 20 pin d.i.l. i.c. holder; 8-pin d.i.l. i.c. holder; stereo jack socket (3 off); stereo jack plug (3 off); 14-way ribbon cable; connecting wire; solder, etc.

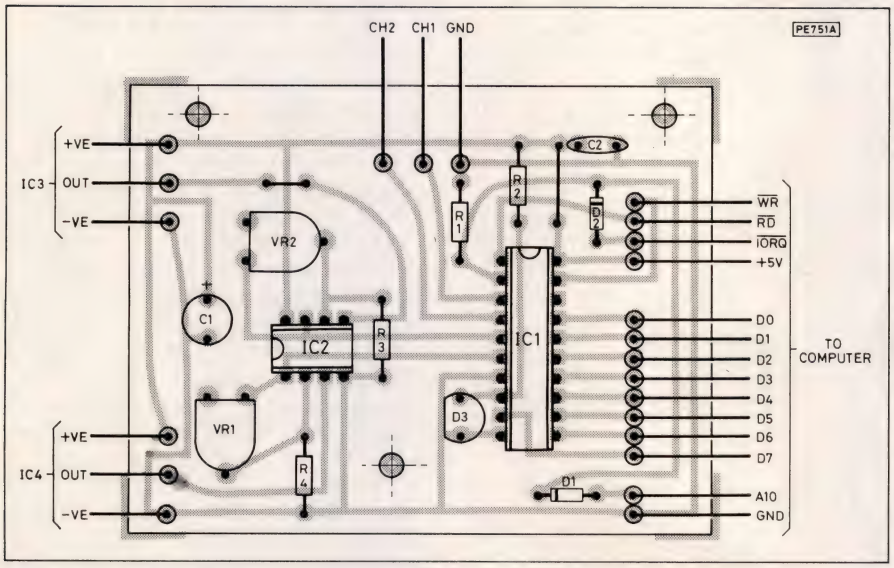


Fig. 3. *P.c.b. design and component layout*

input/output map. Of course, as there is only partial address decoding the circuit can be activated using a large block of addresses, but the one mentioned above is the base address and is a convenient one to use in practice.

In essence the system of input/output mapping adopted for the Spectrum is the same as that used in the CPC464. There is a slight difference in that one of the lower eight address lines is taken low to activate input/output circuits, and one or more of the upper eight address lines are used if additional addresses are required. For the Spectrum it is address line A5 that is gated with the $\overline{IORQ}$ line, and address 65503 that the circuit occupies. Again, due to the partial address decoding the circuit occupies a great many addresses, but in practice 65503 is probably the best one to use.

POWER SUPPLY

The circuit requires a single (+5V) supply. The current consumption is only a few milliamps, and both the CPC464 and the Spectrum can readily supply this.

CONSTRUCTION

Fig. 3 shows the printed circuit board design for this interface. An important point to note is that IC1 is a CMOS device and should accordingly be fitted in a (20 pin d.i.l.) i.c. holder. The other standard antistatic handling precautions should also be observed. There are two link wires which should not be overlooked, but in other respects construction of the board is quite ordinary.

The exact form that mechanical construction of the unit takes will depend on how it is to be used. It can simply be left as a loose board or, like the prototype, it can be built into a case. A third alternative is to incorporate the unit in to some larger piece of equipment. Whatever method is used the printed circuit design of Fig. 3 should be satisfactory.

Assuming that the unit is to be built into its own case, an aluminium box having approximate outside dimensions of 133 by 70 by 38mm is suitable. The temperature sensors would not normally be mounted on the printed circuit board, but would be remotely located and connected to the interface by way of three-way cable. In order to minimise problems with stray pick up of noise it is advisable to use twin overall screened cable, with the screen carrying the negative supply rail connection. On the prototype three stereo jack sockets are mounted on the front panel, and connections from the sensors to the printed circuit board are made via two of these. The third one is used for the two ordinary analogue inputs.

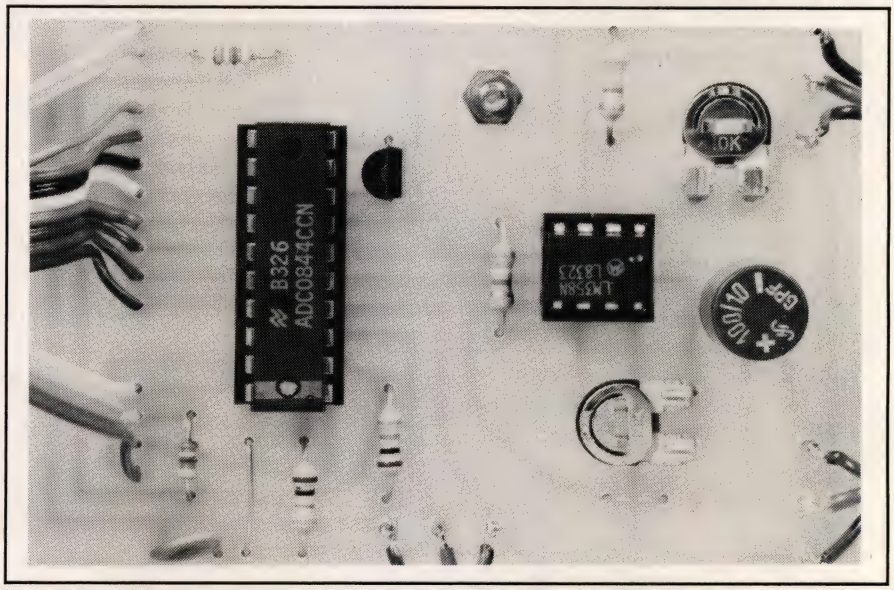


Photo 1. *P.c.b. and component mounting details*

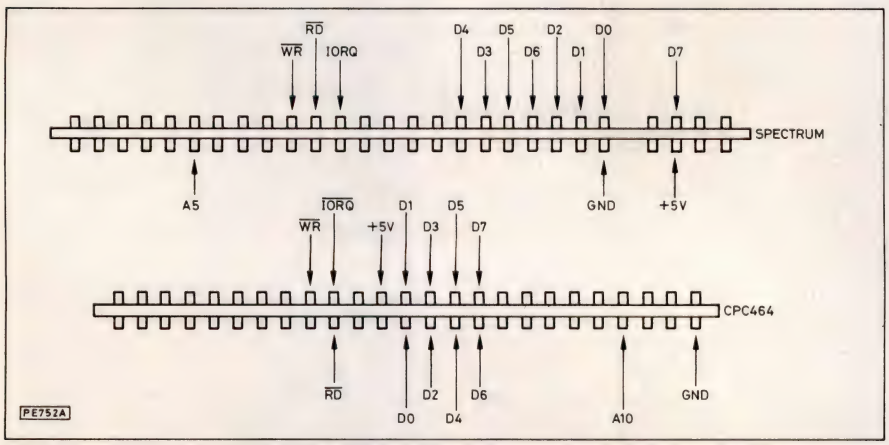


Fig. 4. *Computer connection details*

A 14-way ribbon cable up to about one metre long connects the printed circuit board to the floppy disc port of the CPC464 or the expansion port of the Spectrum. For the Amstrad computer a 2 by 25-way 0·1 inch pitch edge connector is required. As it is unlikely that a connector having a suitable polarising key will be available care must be taken to fit the connector the right way up, and it is advisable to clearly mark the top edge. The Spec-

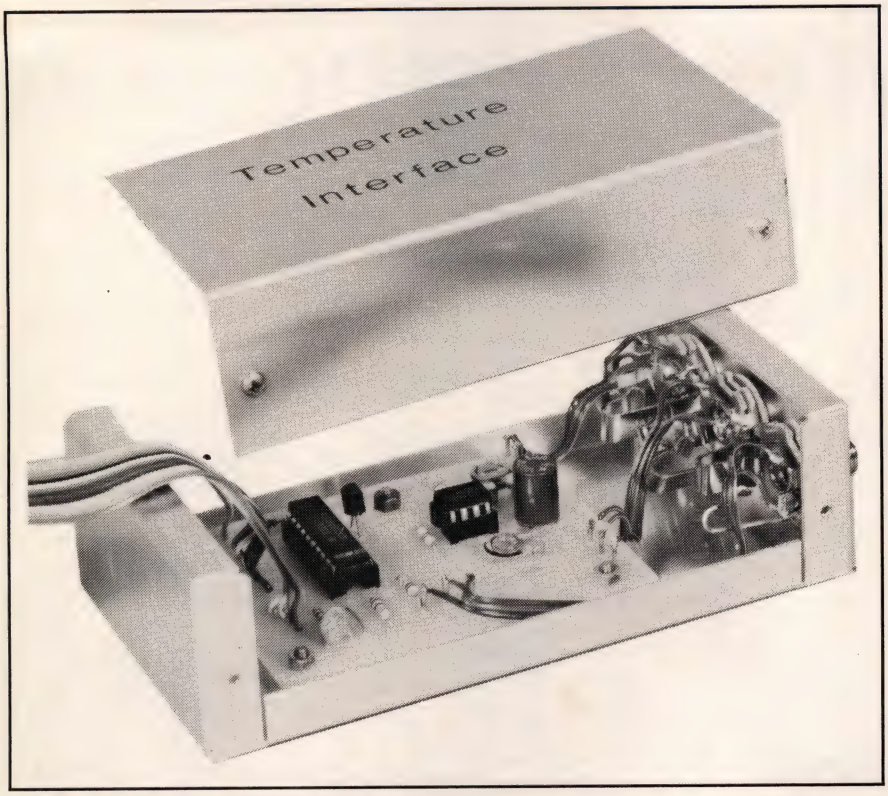


Photo 2. *Constructional details of the Temperature Interface*

trum's expansion port requires a 2 by 28-way 0·1 inch pitch edge connector, and types having a suitable polarising key are readily available. Fig. 4 gives connection details for both computers.

Take great care not to make any wiring errors, and thoroughly check all the wiring once it has been completed. With the specified case it is possible to take the ribbon cable out between the top and base sections, but if an alternative is used it might be necessary to cut an exit slot in the rear panel.

TESTING AND USE

Start with VR1 and VR2 set at about half maximum resistance. Connect the interface to the computer before switching on the computer. The two simple programs shown in Table 1 can be used to give a temperature readout in degrees Centigrade for both temperature channels.

From BASIC, the OUT instruction is used to write the appropriate number to the converter to start a conversion and select the required channel. The number is 6 to read IC4 and 7 to read IC3. The INP function (IN for the Spectrum) is used to read the converter, and as explained earlier, dividing the reading by five gives a reading in degrees Centigrade. The relative slowness of BASIC means that a conversion will always have been completed by the time the unit is read, but when using machine code a delay loop to provide a hold off of at least 40μs will be required.

In order to calibrate the unit both sensors should be taken to a known temperature, and one that represents about 50% to 100% of the full scale value. The two presets are then adjusted to give the correct reading. If the sensors are to be used in liquids they should be fitted in a small test tube or a similar container to protect them. Some silicon grease can be used to give a good thermal contact between each sensor and its container.

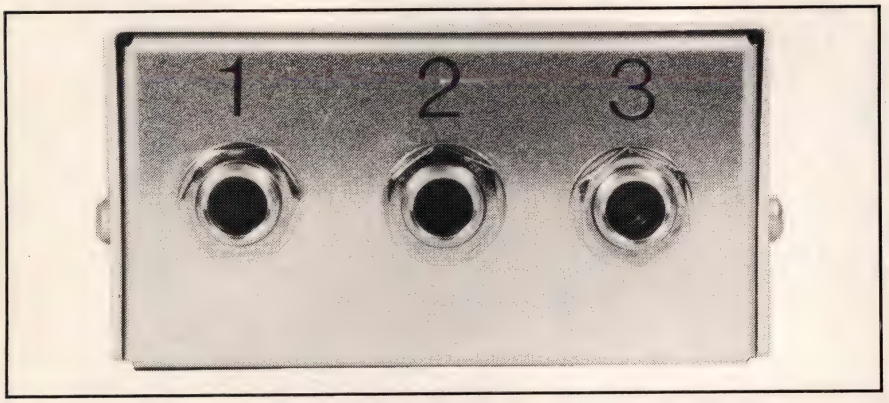
In the single ended mode analogue channels 1 and 2 are selected using values of 4 and 5 respectively. When these are used as a single differential input they are selected using values of 0 (channel 2 is the inverting input) or 1 (channel 1 is the inverting input). PE

Table 1. *Amstrad listing*

```
10 REM CPC464
20 MODE 0
30 LOCATE 8,5
40 PRINT "DEGREES C."
50 OUT &F800,6
60 LOCATE 5,10
70 PRINT (INP(&F800))/5
80 OUT &F800,7
90 LOCATE 15,10
100 PRINT (INP(&F800))/5
110 FOR D = 1 TO 1000:NEXT
120 LOCATE 5,10
130 PRINT "      "
140 LOCATE 15,10
150 PRINT "      "
160 GOTO 50


10 REM SPECTRUM
20 PRINT AT 8,10;"DEGREES C."
30 OUT 65503,6
40 PRINT AT 16,7;IN 65503/5
50 OUT 65503,7
60 PRINT AT 16,20;IN 65503/5
70 PAUSE 50
80 PRINT AT 16,7;"      "
90 PRINT AT 16,20;"      "
100 GO TO 30
```

Photo 3. *Front panel details*



PHOTOGRAPHIC TRIGGER UNIT

BY R. E. HEAD

Sound or light triggered unit which has applications in photography and security

Many photographic trigger units are dedicated to one function; this design is different. It allows a camera to be triggered as an object passes through an invisible narrow beam. The object could be fairly large, such as a fox, or as small as a butterfly. Additionally, the main trigger unit can be switched to respond to noise, allowing, for instance, an effective photograph of a light bulb smashing on impact. The sensitivity of this section of the circuitry is pre-settable.

A block diagram of the system is shown in Fig. 1. Both beam trigger and sound trigger impulses are fed through a selector switch allowing positive or negative operation. In other words, with the switch in one position the photograph is taken when the beam is switched on, or sound occurs. The other switch position causes the photograph to be taken when the beam is broken. Two variable delay circuits are incorporated. The first "trigger" delay controls the time between the beam being broken, or sound occurring, and the photograph being taken. This is variable up to four seconds. The purpose of this delay is to allow framing of a slow moving object, whilst the second delay controls the output pulse width, to control the number of photographs the camera takes. This delay has a control range of 0.5 to 5 seconds.

The units were principally designed to drive a camera motor-wind, which conveniently has a 2·5mm socket to permit the camera to be remotely triggered. For those without such luxuries, two other methods of photography are possible, the first involves using a flash triggered from the beam unit, leaving the camera lens open. This is the fastest possible arrangement but, of course, has to be done in the dark. The final method of taking the picture involves using a solenoid to operate a "Bowden" cable type camera release. This, however, involves constructing some sort of mechanical device, since I have been unable to locate a manufacturer of such an item.

The beam trigger set-up could be used in security systems, either to take a picture or, making use of the output switch, to operate an alarm bell.

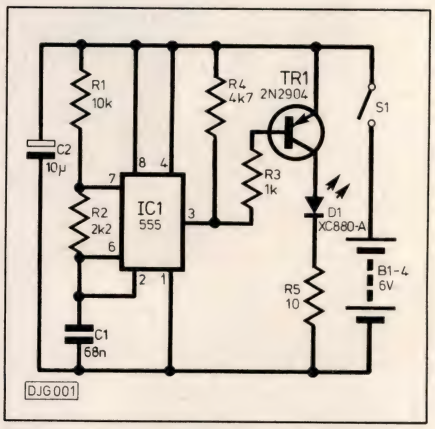


Fig. 2. *Transmitter circuit diagram*

BEAM TRANSMITTER

The transmitter unit, Fig 2, is based around an XC-880-A infra-red (IR) light emitting diode. To allow both high output, with a fair range, and low battery consumption, the diode is pulsed at a ratio of 5:1. An oscillator, an NE555 timer connected as an astable, running at approximately 1500Hz, switches the output to turn on TR1 for 130µs, and off for 530µs. R1 and R2 in conjunction with C1 determine frequency and pulse width.

Output transistor, TR1, is driven by R3 and switches on the output diode via a current limiting resistor R5. The average power consumption at 6V is 40mA, which should give approximately two hours operation from four AA type batteries.

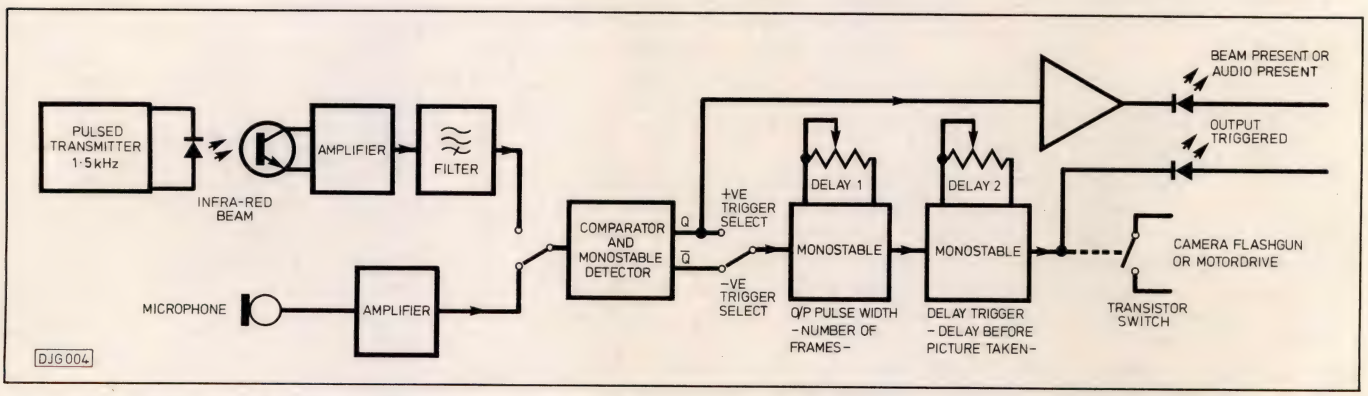


Fig. 1. *Block diagram of the complete system*

BEAM RECEIVER

The beam receiver unit, Fig. 3, is based around a quad op-amp and detects the pulsed beam using an IR photo-sensitive transistor TR1, type

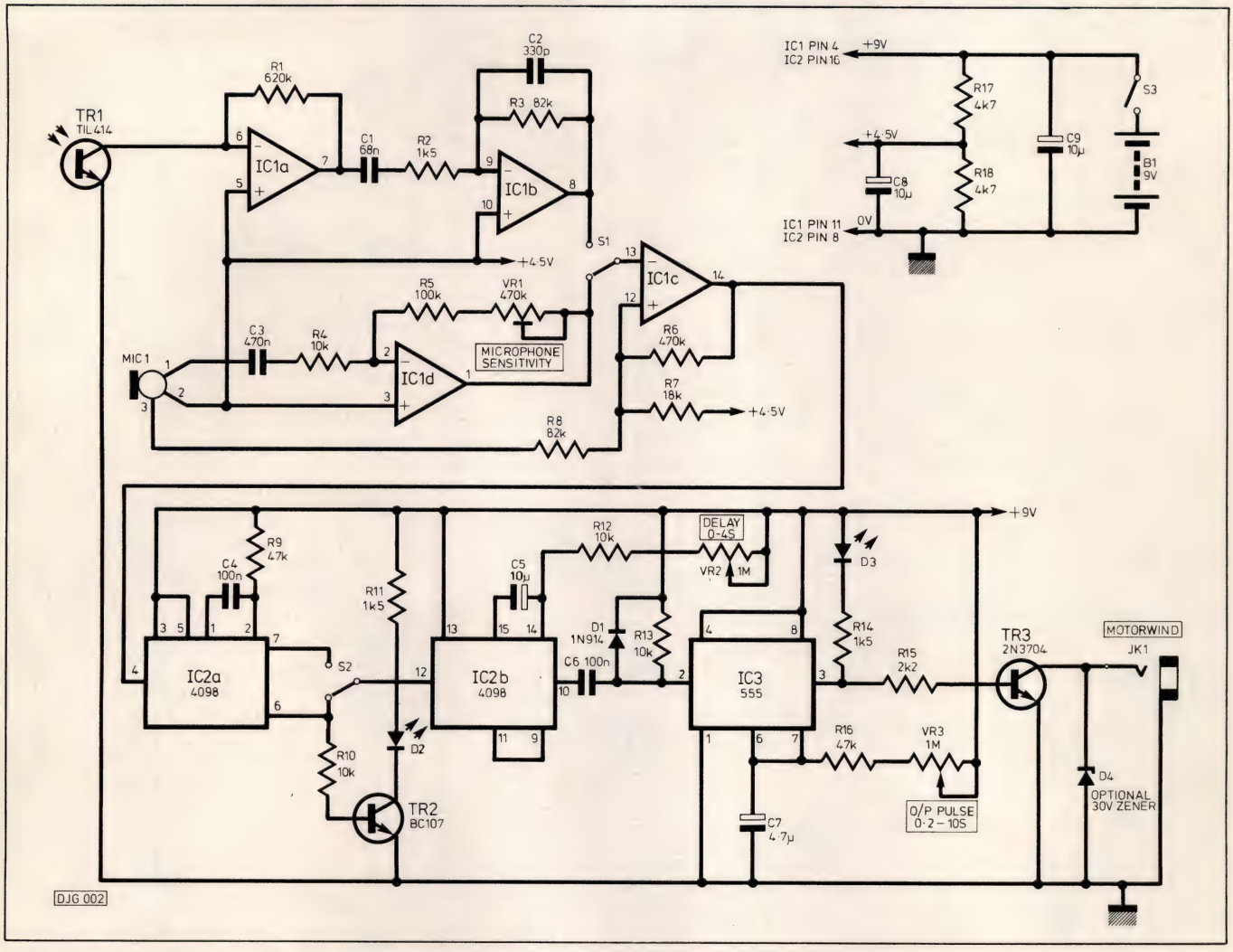


Fig. 3. *Complete circuit diagram of the receiver unit*

TIL414. This is amplified by the first stage op-amp, with the gain set by R1. This stage produces an output of 100mV pk-pk at a range of about 1·5 metres, dependent on ambient light. The second op-amp forms a high-pass amplifier, to reduce the effects of mains lighting pick-up. This stage has a gain of 30 at 1500Hz and approximately unity gain at 50Hz. From this stage the signal is fed to a change-over switch input. The other input to the change-over switch is connected to the output of the third op-amp stage. This amplifies the output from a capacitor microphone insert mounted on the front of the case. The stage gain is controlled by R5 and VR1, a preset potentiometer, and ranges from ×10 to ×100.

The switch selected output is connected to a schmitt trigger, formed by the last op-amp stage, with positive feedback, set to trigger at 3·5V. The output from this stage is connected to the first half of IC2, an MC4098B, wired as a re-triggerable monostable. This has a time constant (TC) of 2ms, controlled by R9 and C4. When the IR amplifier is detecting a series of pulses from the transmitter the output of the monostable remains high (logic one). This then forms the detector stage, driving a light-emitting diode indicator to show a beam is present and correctly aligned, or that sound is present. Both outputs (Q & –Q) from this stage are connected to a change-over switch S2. This allows for the positive or negative modes of operation as mentioned previously. The output from this switch is connected to the positive trigger input of the second half of IC2 arranged as a non-retriggerable monostable with a variable time constant controlled by R12, VR2 and C5. The time constant is variable from 20ms to 4s. The output from this i.c. is differentiated by C6, in conjunction with D1 and R13, the resultant pulse is used to trigger the NE555, IC3.

The output of IC3 drives an l.e.d. to indicate an output pulse. It should be noted that the diode extinguishes to indicate a trigger; and thus acts as a power-on indicator.

Also IC3 drives the output switching transistor, TR3, an n.p.n. switching transistor. This will drive most motor-winds, and some flash-guns. It is important to note that the unit will only drive either of these units, not both together. The type of flash-gun used with the output transistor specified was an Olympus T20; this has only about 2·5V across its contacts, other cheaper models can have up to 300V across their contacts. If possible, check with a high impedance voltmeter the contact voltage before use. (The maximum is around 30V.)

IC3 has a time constant variable between 0·5 to 5s. This corresponds to between 1 and 12 frames when using a 2·5 f.p.s. motor-wind. The time con-

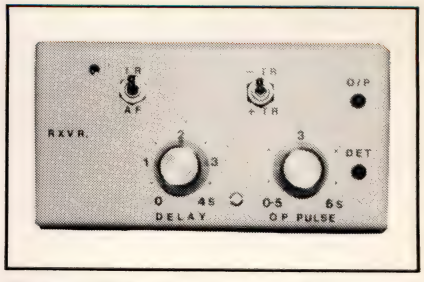


Photo 1. *Receiver front panel*

stant is controlled by C7, R16 and VR3. When used with a flash-gun, the output pulse width control will not function in the same way, in fact, if a fast charge flash-gun is used, it may fire twice if VR3 is set to maximum, and therefore VR3 should be left at minimum.

R17 and R18 form a potential divider across the battery, giving a voltage on the non-inverting inputs of the op-amps of 4·5V. The completed receiver unit runs happily on a PP3 type battery for several hours.

The type of microphone specified for this project is a cheap capacitor insert measuring approx. 9·5mm dia. by 6mm. These microphone inserts require 1·5V, however the prototype ran from 4·5V perfectly satisfactorily.

CONSTRUCTION

Both units are designed to be fairly uncritical in layout, and can be built easily on strip board. However, to produce neat, small, units the prototypes employed two printed boards which allow the units to fit inside small cases.

TRANSMITTER

The p.c.b. design for the transmitter is shown in Fig. 4. Firstly, cut a 30mm length of copper tube. This is anchored to the board by two short lengths of wire, passing through four 1mm holes drilled either side of the tube, and soldered to track on the board. Fit the l.e.d. to the board, such that the body of the l.e.d. inserts into the tube, and bend the wires to fit onto the track. The polarity of this diode is important.

Finally, fit the remaining components, and the i.c. to the board. The battery connector leads should be threaded through the board to provide a reliable anchoring. The on/off switch is wired to the board by two short (65mm) lengths of wire.

When drilling the plastic case, ensure that the fixing holes on the board line up with the mouldings on the base of the box, these are asymmetric to catch out the unwary. The board can be fitted to the case with four 6BA screws. To retain the battery pack in place, two short lengths of self adhesive foam, i.e. draught excluder, should be fitted to the lid of the box.

RECEIVER

The receiver p.c.b. (Fig. 5) should be offered up to the lid of the box before any parts are fitted to it. Then pilot holes (1mm) can be drilled through the lid of the plastic box where the potentiometers, switches, and l.e.d.s are fitted. This method should produce the most accurate positioning when offering up the completed board. The box can then be drilled and legended, Letraset and a fixer spray makes a reasonable job.

A second small board (a small piece of scrap p.c.b. material) is required to hold the detector transistor, or veroboard can be used. The detector transistor, TR1, is fitted on this, lining up with 30mm of tubing as in the transmitter.

The main board is assembled, starting with the two switches soldered through holes on the board. It may be necessary to elongate the holes provided on the board to permit the switch tags to pass through.

The other components can now be fitted to the board, leaving the i.c.s until last. The 4098 is a CMOS device and should be handled with care. The l.e.d.s are fitted to the board spaced away by approx. 10mm. This allows them to poke through the lid of the box. The potentiometers should be fitted last, and are wired to the main board by short solder spills. The shafts of these potentiometers should be cut down if required before fitting. The amount depends on the type of knob selected.

The boards in the receiver are best fitted with tags to solder interconnecting wires to. These tags should protrude through the copper side of the main printed board. The microphone, detector transistor, and battery leads (via S3) can now be soldered on.

When fully assembled, the completed board is fixed to the lid of the box, retained in the lid by the nuts on switches S1 and S2. An appropriate

COMPONENTS . . .

BEAM TRANSMITTER

RESISTORS

R1	10k
R2	2k2
R3	1k2
R4	4k7
R5	10

All $\frac{1}{8}$W unless stated otherwise

CAPACITORS

C1	68n 6V min. ceramic
C2	10 µ 12V min. electrolytic

SEMICONDUCTORS

D1	XC 880–A
TR1	2N2904A
IC1	NE555

MISCELLANEOUS

S1 Miniature toggle switch s.p.s.t.; battery holder to accept 4 × AA cells; battery clip for above with flying leads; wire; solder; p.c.b., PE 103, etc.

RECEIVER UNIT

RESISTORS

R1	620k
R2,R11, R14	1k5 (3 off)
R3,R8	82k (2 off)
R4,R10, R13	10k (3 off)
R5	100k
R6	470k
R7	18k
R9,R16	47k (2 off)
R15	2k2
R17,R18	4k7 (2 off)

All $\frac{1}{8}$W

CAPACITORS

C1	68n min. ceramic
C2	330p polystyrene
C3	470n min. ceramic
C4,C6	100n min. ceramic (2 off)
C5	10µ 16V tantalum
C7	4µ7 16V tantalum
C8,C9	10µ 12V min. electrolytic (2 off)

SEMICONDUCTORS

D1	IN4148
D2,D3	$\frac{1}{4}$ inch l.e.d. (2 off)
TR1	TIL414 (Tandy 276–145)
TR2	BC107 or similar
TR3	2N3704
IC1	074 bifet op-amp
IC2	MC4098B dual monostable
IC3	NE555 timer

POTENTIOMETERS

VR1	470k min. preset
VR2,VR3	1M miniature linear (2 off)

MISCELLANEOUS

S1,2	Miniature toggle switch s.p.d.t. (2 off)
S3	Miniature toggle switch s.p.s.t.

Case; light tube; battery clip and battery; electret microphone insert (Tandy 270–092); 2·5mm jack socket, p.c.b., PE 104, etc.

Note: If a shorter delay is all that is envisaged on the first trigger delay section, fit a 1µf capacitor instead of 10 µF for C5. This will then delay up to 400ms instead of 4s and give a more precise control over the range.

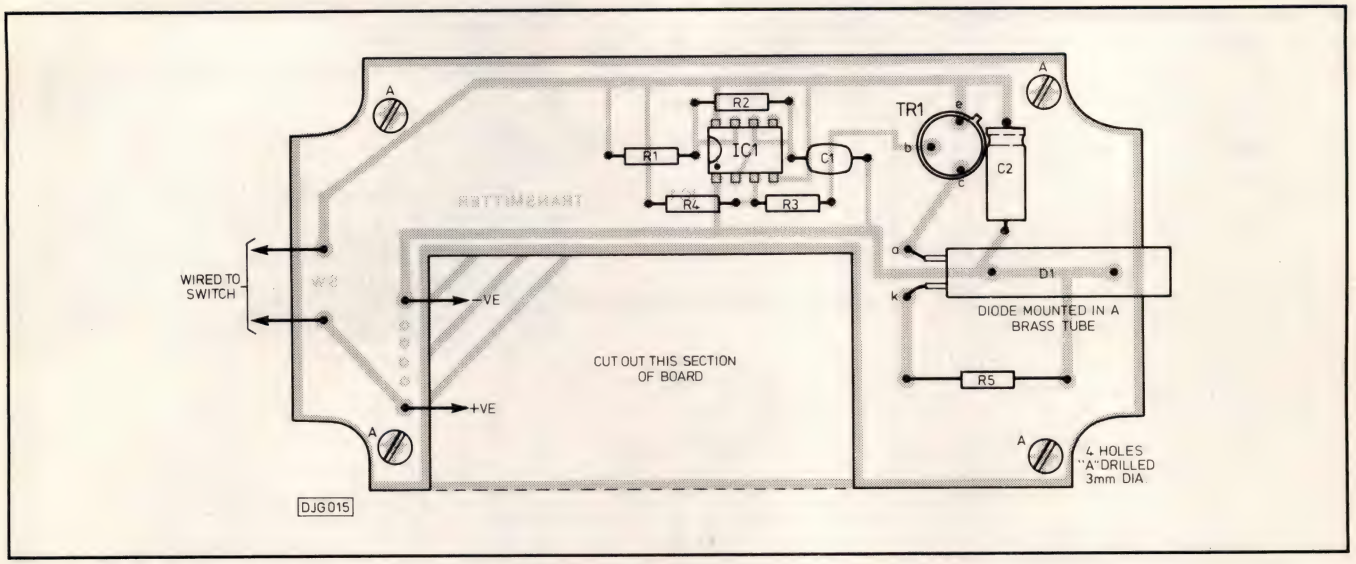


Fig. 4. *P.c.b. design and component overlay of the transmitter unit*

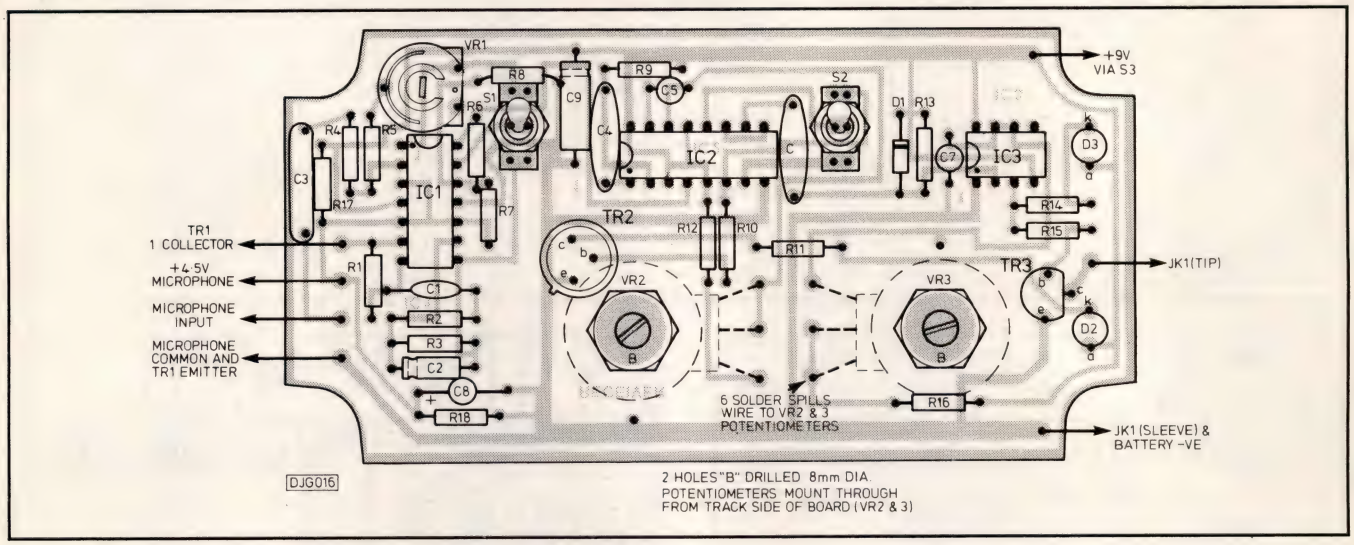


Fig. 5. *P.c.b. design and component overlay of the receiver unit*

spacer (14mm) can be used additionally if desired with a fixing nut and bolt. The nut on the printed board should be provided with an insulating washer to prevent any short circuits. The lower small board is fixed at one end of the box with two small 6BA screws to line up with the hole drilled in the case.

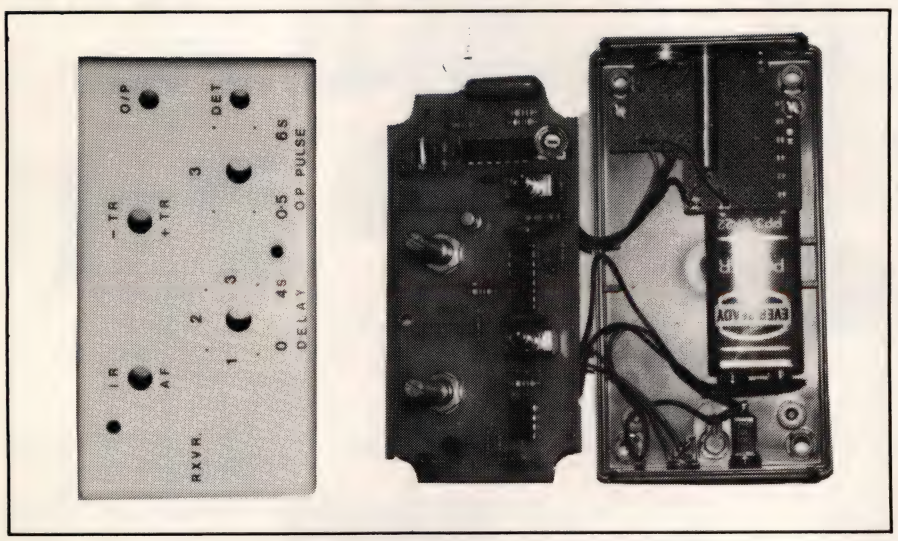


Photo 2. *Receiver constructional details*

TESTING

To begin testing, apply the 6V volt supply to the transmitter board, if possible, checking the current consumption, which should not be more than 40mA. If an oscilloscope is available, check for 1·5kHz pulses across the l.e.d. which should be approx. 1V pk-pk. If the pulses are significantly larger, and the current consumption very low, check the polarity of the l.e.d.

To test the receiver, connect the 9V battery, again checking current, which should be in the order of 20mA. The output l.e.d. should light up. It may pulse off briefly, but should normally remain on. Check with a voltmeter the junction of R17 and R18 which should be in the order of half the supply voltage. A 10% error on this is quite acceptable, more should be checked, in

particular check the current through the microphone which should be around 2mA.

Next, check the voltage at the output of each amplifier stage. This should be approximately half the supply voltage for all amplifiers bar the schmitt trigger, whose output is at 0V.

The two units can now be switched on together. Line up the transmitter and receiver on a flat surface, and switch both p.c.b. toggle switches upwards. The lower l.e.d. should light, indicating that the receiver is detecting the IR beam from the transmitter.

With both pots turned fully ACW, the action of breaking the beam should cause the lower l.e.d. to extinguish briefly, and the upper l.e.d. to go out for about 0·5 seconds. The control on the left, "delay", will introduce delay between breaking the beam, and the output l.e.d. indicating. The second control should alter the amount of time the output l.e.d. is off.

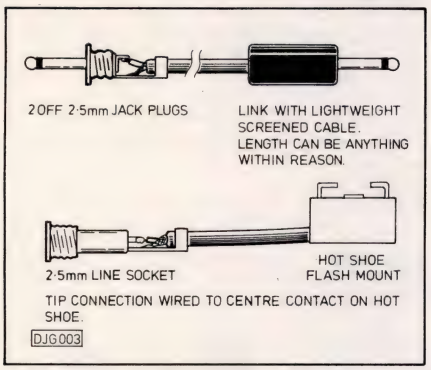

2OFF 2·5mm JACK PLUGS
LINK WITH LIGHTWEIGHT SCREENED CABLE. LENGTH CAN BE ANYTHING WITHIN REASON.
2·5mm LINE SOCKET
HOT SHOE FLASH MOUNT
TIP CONNECTION WIRED TO CENTRE CONTACT ON HOT SHOE.
DJG003

Fig. 6. *Jack-plug connections*

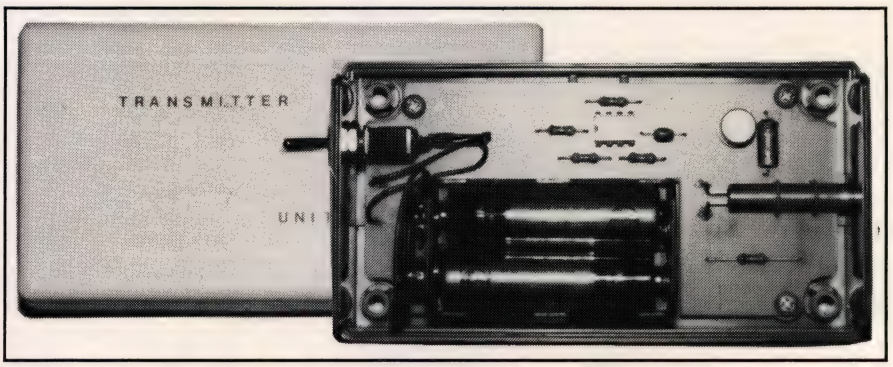


Photo 3. *Transmitter constructional details*

A double ended lead should be made up with a 2·5mm jack plug at each end, as shown in Fig. 6. This and the set-up can be tested with a 9V battery and a lamp wired across the jack which should indicate when the beam is broken, or with the selector switch moved, when sound occurs.

To use the units with a flash set-up, a hot-shoe mount with the plug cut off and substituted by a 2·5mm line socket, will mate with the cable already mentioned.

CONCLUSION

As mentioned earlier, the units have an approximate range of 1·5 metres. This may be reduced slightly if used in bright sunlight, due to the detector transistor saturating. Alignment is fairly critical, and can be assisted by placing both transmitter and receiver on a strip of wood whilst setting up.

If the units are requred for security purposes, the transmitter can be modified for 9 volt operation by simply changing R5 to 16Ω, allowing the two units to be fed from a common regulated power supply. PE

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FROM THE EDITOR . . .

After twenty-one years at IPC, Practical Electronics is going through a great upheaval. I am using the change of ownership to examine whether the editorial contents of PE is what readers want. In last month's issue the magazine carried a questionnaire, replies to this are flooding in and have enabled me to undertake a preliminary analysis of what you, the readers of PE, want to see in future issues.

ANALYSIS

The analysis indicates that readers feel PE has not kept up with the constant changes in technology, a situation I intend to rectify. A substantial majority of PE readers possess a home computer, and consequently an interest in micro-processors, computer interfacing and computer related projects is expressed by many. This data is proving very useful in formulating future editorial policy. I am instituting editorial changes, but all PE's loyal and regular readers can rest assured that these changes will not be substantial and are aimed at improving editorial quality rather than altering the magazine's direction.

POLICY

The key element of the new editorial policy is good forward planning. This will enable the editorial department to thoroughly check all projects, it will also ensure that our advertisers are able to supply all the key components of a project on the date of publication. Good forward planning will also allow a continuity between projects. An example of this proposed continuity is given in the article 'Setting The Standards' in this issue; a common system of interconnection is the basis of any continuity between different projects.

NEXT MONTH—this issue has a very interesting set of major articles. The single board computer system (IEE1000) is continued with the completion of the power supply and the backplane. Also starting is the PE Hobby Bus—which will give a standard I/O bus for all home micro interface projects. For mariners the DF Beacon Timer will prove a valuable offshore navigation aid and for the workshop, a useful piece of test equipment is the Logic Checker project.

TECHNOLOGY EXPERIMENTS

Solar energy will be the first subject in a new series of feature articles on electronic technology experiments; the article will have particular emphasis on solar cells. For those interested in robotics there is an article on the biological basis for robotics system design. Finally, along with all our regular features, there is a project for electronic music enthusiasts—an Echo Reverb Unit.

I am sure you will find the May issue of Practical Electronics great reading.

NICK HAMPSHIRE . . .

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SPACEWATCH

BY DR PATRICK MOORE OBE

PROJECT ULYSSES

Over the past few years it has been found that our knowledge of the Sun, our nearest star, is probably much less extensive than we have fondly believed. In particular there is the 'neutrino problem'; the Sun is emitting far fewer neutrinos than in theory it ought to do—as we know from the experiments being carried on at Homestake Mine in South Dakota and also in the Soviet Union. Neutrinos, which have no mass (or virtually none) and no electrical charge, are very hard to detect, and one way to do so is by interactions with chlorine, producing radioactive argon. At Homestake Mine, a vast tank of chlorine-containing cleaning fluid has been set up a mile below ground (to provide a shield against cosmic rays) and the experiment seems to be reliable. One solution would be to reduce the Sun's core temperature from 15.8 million degrees to only 14 million degrees; this would explain the paucity of neutrinos, but raises other theoretical problems.

There is also the problem of the solar wind. From information sent back from the deep-space probes to the outer planets, it seems that the solar wind is not 'slowing down' at great distances as had been expected. At present, however, most of our information comes from probes operating not far from the main plane of the Solar System. A new project, Ulysses, is designed to pass over the Sun's north pole, and obtain data from previously unexplored regions.

Ulysses is scheduled to blast off in May 1986, from the Shuttle Challenger and thence by a Centaur rocket. It will first go out to the region of Jupiter, arriving there in July 1987, and will use Jupiter's gravity to move the probe out of the ecliptic plane and swing it back sunward, so that in early 1990 it will pass over the north pole of the Sun. Experiments carried on the probe will deal with magnetic fields, solar-wind plasma, particles of various types, cosmic rays, solar X-rays, and cosmic dust. The mission will officially end in February 1991, though it is true that many recent missions have continued for much longer than expected.

THE REMOTEST GALAXY

Up to now the holder of the 'distance record' has been held by the quasar PKS 2000–330, which has an estimated distance of 13,000 million light-years; it was discovered at the Parkes Radio Astronomy Observatory in Australia, and optically confirmed at Siding Spring. Now the record may be challenged—this time not by a quasar, but by a galaxy!

The research has been carried out by S. Djorgovski and his team at Berkeley in California. Using the Lick 120-inch reflector, they studied the region of a faint quasar in Hercules, and discovered a separate object which proved to be a galaxy with an even greater red shift. Its magnitude is 24.5, but a reliable spectrum was obtained, and if the red shift is to be trusted the distance must be at least comparable with that of PKS 2000–330.

Of course, the Doppler interpretation of the red shifts for quasars has been challenged by a few astronomers, notably Sir Fred Hoyle, but the red shifts of the galaxies have been more universally accepted. If Djorgovski's work is confirmed (as there is every reason to expect), it will further strengthen the argument that the red shifts of all very remote objects are indeed cosmological. And if Hubble's constant holds good, we may come to the end of the observable universe at between 15,000 and 20,000 million light-years, probably rather closer to the lower figure—though we must al-

THE SKY THIS MONTH

This is still not a very good time for planetary observers. Mercury is on view as an evening object for the first ten days of the month, low above the western horizon for about half an hour after sunset, and between March 6 and 11 it is not far from Venus—though, needless to say, there can be no confusion between the two; Venus, at magnitude −3·4, is far brighter than any other star or planet. Both Mars and Saturn are morning objects, but neither is at all well placed, though by the end of March the magnitude of Mars has increased to 0·3, about the same as that of Saturn. Jupiter is virtually out of view throughout the month. There are no important meteor showers; the Arietids last from about the 14th to the 18th, but the hourly rate is always low. Neither are there any eclipses.

By now, of course, we will have the news from the Voyager 2 pass of Uranus. I will be able to give it, in full, in my notes for next month.

The brilliant winter stars are starting to be lost in the evening twilight, though Orion is still on view soon after sunset, and Sirius remains above the horizon during the early part of the evening. The Great Bear is in the north-east. Use the 'Pointers' the wrong way—that is to say, away from the Pole Star—and you will reach Leo, the Lion, the main spring constellation, with its first-magnitude leader, Regulus, and the characteristic curved line of stars which makes up the famous 'Sickle'.

The rest of Leo consists of a triangle of stars to the east of the Sickle, of which the brightest is Denebola or Beta Leonis. In ancient times Denebola was ranked as being of the first magnitude. Today it is slightly below the second, and a full magnitude fainter than Regulus. It is one of several stars which have allegedly altered in brightness over the past two thousand years or so, but whether there has been any genuine change in these so-called 'secular variables' is a matter for debate. Denebola, which is a white star of spectral type A, does not seem a likely candidate, and on the whole it seems more probable that there has been an error in interpretation or translation. Another case concerns the Twins, Castor and Pollux, which are still high up. Castor, formerly regarded as the senior of the pair, is now about half a magnitude fainter than Pollux, but again it is hardly likely that there has been a real alteration.

Castor and Pollux point downward to the orange star Alphard, leader of the constellation of Hydra (the Watersnake). Hyrdra is the largest constellation in the entire sky, but also one of the dullest, and Alphard is its only star of note. It is reddish, and nicknamed the 'Solitary One' because of its isolated position; the magnitude is 2. It has been suspected of slight variability. This would not be unexpected but even if there are fluctuations the range is only a few tenths of a magnitude at most. Alphard is 85 light-years away, and is 115 times as luminous as the Sun.

ways bear in mind that this refers only to the *observable* universe, not necessarily to the universe itself.

COMETS: GRAVEL-BANKS OR DIRTY ICEBALLS?

During the first part of this month five probes will be on their way to a rendezvous with Halley's Comet. Two are Japanese, two are Russian and one is European—built by British Aerospace in Bristol, and successfully launched last July from French Guiana. On the night of March 13/14, Giotto is scheduled to pass right into the heart of the comet, and—we hope—send back close-range pictures of the nucleus.

Up to now we have known very little about cometary nuclei, because we have never been able to see them properly. When a comet has no obvious head, it is so far away that it is quite beyond the range of any telescope to show details; and when the comet draws in toward the Sun, the nucleus surrounds itself with an 'envelope' through which we cannot see.

The accepted theory, due initially to the great American astronomer Fred Whipple, is that a nucleus is a 'dirty iceball', and that when the ices are warmed the coma is produced—together with a gas tail (driven out of the coma by solar wind) and a dust tail (driven out of the coma by the pressure of sunlight). But not everyone agrees, and in particular there is a theory due to R. A. Lyttleton that the heart of the comet is more in the nature of a flying gravel-bank or flying sandbank. On this picture, each particle follows its own orbit; when the comet nears perhelion the particles collide, producing the effects we see. And if Lyttleton is right, then Giotto will show no 'dirty iceball'.

Lyttleton also doubts the existence of the so-called Oort Cloud, from which comets are thought to come; he believes that the comets are collected by the Sun during its journey round the centre of the Galaxy. Obviously we cannot see the Oort cloud; it is much too far away. But if Lyttleton's gravel-bank theory is found to be correct, then he may well be right also about the non-existence of the Oort cloud.

It must be said that Lyttleton and his supporters are very much in the minority, but this is one question which will be cleared up within the next week or so—provided that Giotto functions properly. Both Whipple and Oort will be at Darmstädt, in Germany, headquarters of the European Space Agency, where the Giotto pictures will be produced as soon as they are received from the Parkes radio telescope in New South Wales. I may add that I will also be there, and I hope to be able to give a full report in an issue of *Practical Electronics* as soon as possible. My view is that Whipple will be proved right and Lyttleton wrong; if not, then we must all do some radical re-thinking.

Meantime, the eccentric fringe has been in full cry, and all current disasters, both natural and political, are being laid at the comet's door. At a meeting of the Halley's Comet Society in Wembley, a band of demonstrators waved around a vast placard announcing that the end of mankind was nigh, and we had all better repent immediately. Another group forecast that the world would be destroyed when the comet reached perihelion. (As this occurred on 9 February, we will know that this particular forecast is wrong—if we were all still here in March.) On a lighter note, one man in Malvern claimed that the comet had made him lose two teeth—he broke them because they chattered so much when he was searching for Halley on a chilly night. I have my own personal disaster; on coming out of my observatory dome after photographing the comet I slipped, fell, and dislocated my shoulder and broke two ribs! But I fear that I must blame myself, not Halley . . . PE

REGULAR FEATURE

(continued from page 15)

true 16-bit chips are still brutes to make!

Whatever happens about 16/18-bit resolution, domestic compact disc player quality is already so good that it shows up deficiencies in the original recording. For the first time home reproduction equipment can be better than professional studio recording technology. So studios are switching to digital recording.

There are two quite different technologies available. The cheapest relies on a domestic or industrial video recorder to capture the rapid data stream produced by a "processor" which converts a two channel analogue signal into pulse code modulation. A Sony PCM processor costs from under £1,000 and works to the same standard as compact disc (44·1KHz sampling, 16-bit coding). It can only be used to tape two sound channels at a time. Broadcasters and small studios use them to record stereo direct from a pair of microphones.

STATIONARY HEAD

The more expensive approach is stationary head recording. This can be used for taping more than two channels of sound at the same time i.e. for multitrack recording. The recording industry is currently trying to decide between two competing and incompatible technologies. Sony originated the DASH (digital audio stationary head) format, and is now backed by Studer of Switzerland. The tape runs fast past a stationary head which is divided into very small segments so that it records narrow parallel tracks on the tape.

DASH

Sony's 24-track DASH recorder uses 12·5 millimetre tape. It runs at 76 cm/sec past a recording head which is subdivided into 24 sections, one for each sound channel. The tape must accurately record 1·5 kilobits of data per millimetre. The next generation of DASH will double recording density and either allow the tape to run at half speed or record double the number of sound channels recorded. So far only prototype double density DASH recorders have been demonstrated because the heads must be made by thin film technology. Instead of machining the head gaps, they are etched by a photo technique similar to that used for micro chip production. A single density 24-track DASH recorder costs nearly £100,000 so only the most successful studios can afford to buy one.

ALTERNATIVE

Mitsubishi has developed an alternative stationary head system. The X-800 records 32 sound channels but uses 25mm tape. Mitsubishi claims its X-system is virtually immune from errors caused by tape blemishes because 8 extra tracks are recorded for the sole purpose of duplicating data recorded on the main tracks. Because DASH and Mitsubishi X-system tapes are not interchangeable, the recording industry is now trying to decide which system to adopt. Every week the two companies announce some new sale or deal with recording studios round the world. Already it seems certain that the recording industry is stuck with a split standard for digital recording. The first company in the field, 3M, has disappeared from the scene. 3M's very expensive stationary head multitrack recorder—which was compatible with neither DASH nor X-system—has sunk without trace. PE

SILICONE CONTAMINATION

BY GERALD KINGSBURY

"Silicones can travel, and when they do, the results can be disastrous"

WHEN in doubt, electronics engineers and amateur enthusiasts alike tend to attribute the snap, crackle and pop type of interference which plagues all manner of electronic equipment, to such causes as "airborne contaminants", "oxidisation" and "dirty contacts." Lay observers blame the aberrations on still more nebulous phenomena such as static!

Yet despite painstaking efforts to ensure apparatus is well maintained, audio equipment often persists in crackling like a bonfire, video displays fuzz momentarily, or jar the eyes with distortion, and computers vex their operators by crashing for no apparent reason.

HIDDEN MENACE

Varied are the reasons why electrical/electronic equipment does fail with such maddening inexplicability, but comparatively recent research has unearthed a hidden menace which may well be responsible for the majority of "open circuit" fault conditions, and it is a self-inflicted menace at that!

It is our propensity for using silicones to polish, act as release agents, lubricate, and conduct heat that gets us into trouble. It seems that our ally, the silicone, is also our enemy! Silicones can travel, and when they do, they bring disaster.

Scientists around the world are alerted to this less welcome effect of using silicones in an electrical environment. Researchers working for Hitachi in Japan, and others working for America's Bell Laboratories have demonstrated that unreacted silicones—often found in badly formulated *contact lubricants,* and many household furniture polishes—can cause havoc when used near, or actually on, relay and switch contacts. Further, the nature of abrupt failures due to silicone containing films is related to the degree of electrical energisation, or duty, of the contaminated contacts.

You see, it all stems from the fact that unreacted silicones are able, and indeed have a tendency to creep around on surfaces. Researchers discovered that failed relay contacts behind a central office panel had "dimethyl silicone" oil present on their surfaces. More worryingly, they discovered that this oil had spread over intervening surfaces and wires from silicone lubricated equipment several feet away!

The cause of contact troubles in telephone equipment has been traced to vapours rising from nearby silicone oil baths, while in another instance, silicone carbide crystals were found on the surface of a silver contact, despite the fact that the contacts had no silicone-based compounds between their surfaces. The crystals had appeared through migration from a silicone-based heat transfer compound applied to a thermostatic controller elsewhere in the equipment. The failed contacts were operating on a light load of only 12V d.c. and had survived a mere 7000 cycles before going open circuit.

CONSEQUENCES

The most common silicone fluids and oils are dimethyl silicones, which tend to spread over almost all types of surface, including relay contacts and their springs. The rate at which they creep around depends upon the nature of the substrate, the temperature, and on the fluid's viscosity. When the spreading offenders reach a set of contacts the temperatures brought to bear by arcing form the silicones into hard, rock-like crystals, notably silicone carbide. These crystals then cause a lack of electrical continuity with high contact resistance, leading ultimately to open circuit condition. The user of silicone contaminated apparatus therefore perceives a catastrophic increase in contact resistance, manifesting itself at first in sporadic, and then continuing "opens".

The damaging effect of silicones is promulgated by a Russian research paper which points out that whilst silicones have proved extremely valuable as insulation material in electrical systems, in many classes of rotary machines their use can lead to accelerated brush wear. This is presumably brought on by the formation of silicone carbide crystals.

The greatest concentration of silicone deposits—and hence the most harmful—are likely to be found in totally enclosed machines, or those with poor ventilation, says the report. "The increased rate of brush wear can be from 20 to 200 times the normal rate and, in exceptional circumstances, 800 times the rate."

Common sources of silicone compound contamination in electrical systems are the dimethyl silicone oils and greases used on associated moving parts. One example of this was identified by American Researchers studying a motor-driven interrupter, in which silicone oil was used as a lubricant for the motor and driving gears. The silicone oil quickly spread to the cams, and then the contacts they actuated. After a short time, the units failed!

WE'VE TAKEN A SHINE TO THEM

Another "vehicle" for silicone contamination is the *mysterious one* who comes around to clean and polish things when you are not there. Be that person housewife or contract cleaner, the aerosol mist polish incorporated in the cleansing arsenal is not only liable to put an external shine on enclosures containing switchgear—and that includes the humble telephone—but eventually render their contents unserviceable. What the "gleam-makers" do not know is that furniture polishes often also contain silicone fluids; so in schools and offices cleaners may quite unwittingly be the cause of data losses and read/write errors in otherwise carefully maintained computer equipment.

Gerald Kingsbury is the Managing Director of Electrolube Ltd. Electrolube manufacture and supply a range of solvents and lubricating compounds to remove and protect against silicone contamination.

Photo 1. *Silicone contamination, the hidden menace, caused by innocent use of spray polish*

And the mischievous antics of silicones do not end there. Some office copying machines release vapours containing silicone oils, black pigments and polymeric binders, in addition to the usual paper fibres. Alarmingly, a number of PBX machines have been rendered inoperative by the proximity of such copiers.

THEY'RE EVERYWHERE!

The use of silicones as encapsulants, potting compounds or sealants in the electronics industry is now widespread, but it can lead to grief when these materials are improperly formulated. Take, for example, the problems experienced with key-telephone units, which were traced back to silicone oils bleeding from a silicone compound used to encapsulate a reed relay. The invisible oils migrated over a printed circuit board and up onto relay contacts located over an inch away. Dimethyl silicones are frequently used to "plasticise" or modify the viscosity of silicone formulations, and these will bleed from the compound, given time.

In all of these instances the propensity of dimethyl silicone oils to spread has the effect of continually renewing the offending liquid film on contact surfaces, which in turn results in yet more black insulating deposits.

CALL IN THE EXPERTS

Hitachi's Production Engineering Research Laboratory looked at the problem in depth in an attempt to discover the composition of the contaminants on failed contact surfaces, and the process changes silicones into insulating film. The researchers examined an electrical control system which had broken down because of a failed relay.

The dust-proof relay consisted of a base with terminals, a coil, a magnetic circuit, armatures with a contact on top of each, leads between the terminals and armatures, a return spring, and a plastic cover. The silver contact contaminated with the carbonaceous black powder, and which was plated with 3 to 5μm gold, was operated about ten times a day. At 24 volts it was energising a 240 Ohm inductive load, and gave trouble after several months service. In the laboratory, the resistance of the failed contact was measured as over 100 Ohms. Because, in general, a contact coated with carbonaceous black powder seldom goes to such a high resistance it was concluded that the contaminants comprised something extra. Indeed, using a wavelength X-ray micro analyser it was discovered that these contaminants were composed of carbon *and silica.*

WHAT THEY FOUND

From their experiments, Hitachi researchers deduced that the following sequence of events takes place:

1) As the internal temperature of the relay rises due to coil energisation, low molecular weight organics are vapourised from the organic materials within the relay. These vapours fill the space inside the cover, during which time some are adsorbed by the contact surfaces.
2) In this state, if the contacts are operated repeatedly, these adsorbed organics are decomposed to silica, carbon and gaseous materials by the contact arcs or molten metal bridges.
3) A vicious circle follows. The more carbon that adheres, the more organic vapour is adsorbed, and as a result, contact arcs occur more readily. The contaminants accumulate rapidly towards failure point.

By mixing carbon and silica together in powder form, and in differing proportions, the researchers also discovered that contacts polluted at under 40 per cent silica did not fail. This curious 40 per cent point coincided

WHAT ARE SILICONES?

Look up Silicones in *"Comprehensive Inorganic Chemistry"* published by Pergamon Press, and you will find this description: "The organopolysiloxanes, popularly known as silicones, consist of a framework or backbone of alternate silicon and oxygen atoms clothed by certain selected organic groups attached directly to the silicon atoms."

Such qualities as *"thermal stability"* and *"chemical inertness"* are cited, the latter meaning resistance to oxidation. Silicones are unknown to the natural world, with no relatives or precursors in it, and in reference works the quality *"unnaturalness"* is referred to. High molecular weight silicone polymers are insoluble in organic liquids, with the useful outcome that they are "bland and protective" towards human skin.

A surface coated with methyl silicone has a high contact angle to liquid water, which means it is water repellent. Only a few of the theoretically possible silicone polymers are considered useful and therefore manufactured. But certain silicones are used widely in liquid form to put a finishing film on paper, textiles and masonry. Another application is as a bonding agent in glass fibres.

–Si–O–Si–O–Si–O–Si–O–

with the point at which the resistivity exceed 100 Ohms. They concluded that, in the initial state, the contaminants are carbon rich, but that the carbon is gradually burned off by arcing (yielding carbon dioxide) while the silica remains behind. This explains another observed phenomenon, that the percentage of silica in the mixture varies in proportion to the number of contact operations, and the catastrophic failure point.

THOU SHALT NOT . . .

There are a number of steps which can be taken to reduce this kind of failure. The most obvious precaution is to avoid the use of silicone oils, greases and fluids altogether in the locality of contactors. Even high molecular weight, high viscosity silicone lubricants generally have low molecular weight fractions that tend to creep from the base material. Silicone mould releases should not be used for moulded parts, and silicone materials used to coat, encapsulate, insulate or pot electronic and electrical components

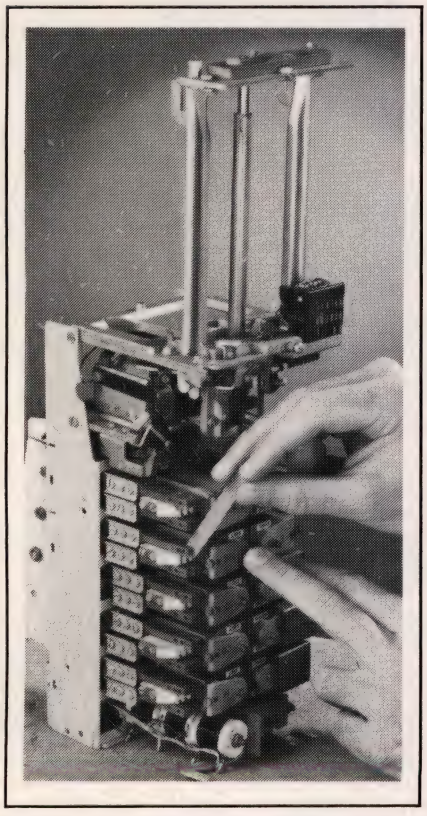

Photo 2. *Special cleaning tools, now available, used to overcome silicone contamination*

should be carefully selected and formulated. The results of experiments designed to discover ways of avoiding this class of failure are now widely known to many scientists.

There are other problems to guard against. In the very smallest concentrations the presence of silicones will cause problems with paint and coating

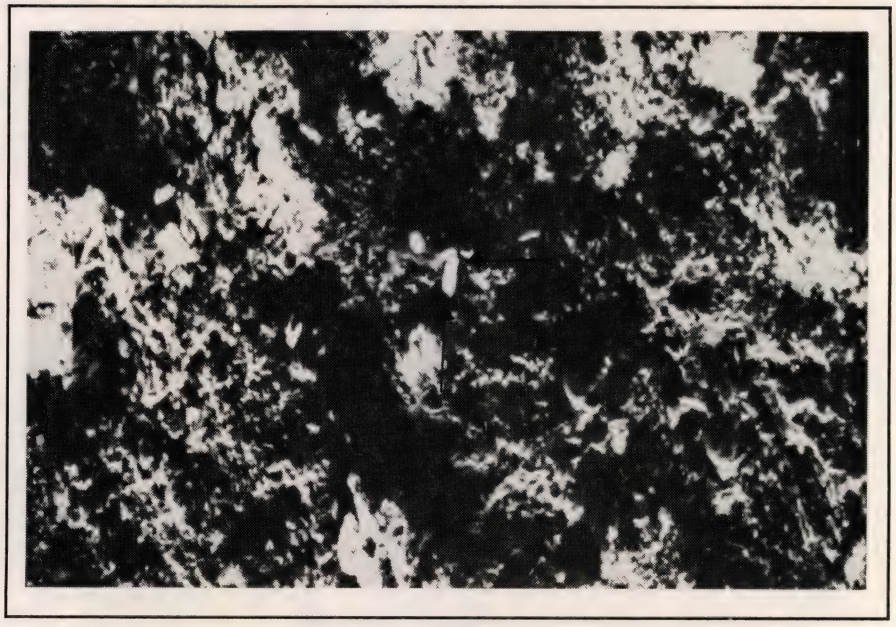

Photo 3. *Electron micrograph showing a crystal of silicone contamination*

adhesion. Silicones are cunning too, for even if printed circuit assemblies are cleaned in a tank of Arklone of Freon (trichlorotrifluorethane) any silicones on the board will dissolve in the solvent and effectively contaminate further boards cleaned in the solvent.

example, are inert to all plastics tested and can be used to break down silicone compound crystals so that they are easily removed. Continued use of Eltinert will prevent the reformation of the crystals and, of course, if Eltinert is used as a lubricant initially, the problem will not occur.

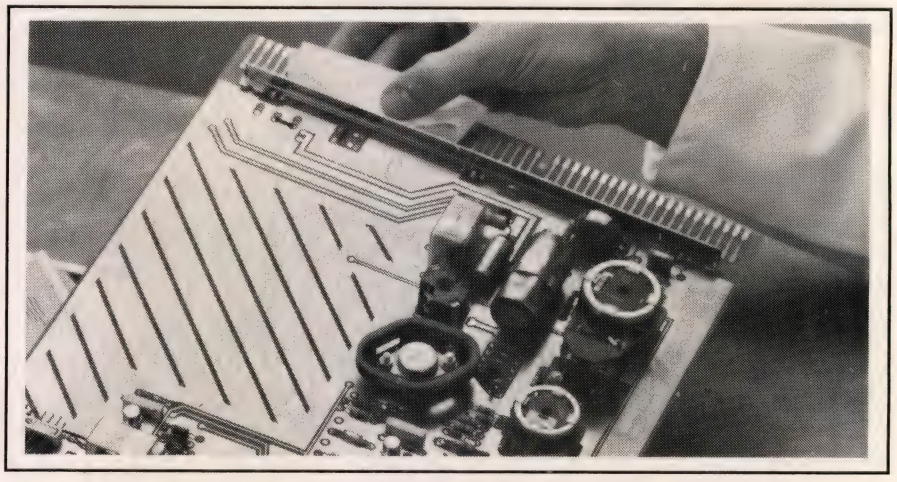

Photo 4. *Use of solvent impregnated cloth to guard against contamination*

PRODUCTS RETHINK

Electrolube has been aware of the problem of silicone contamination since the early 1960s when it launched the pioneering research and development programme which led to the introduction of the 2 and 2X range of non-silicone based lubricating products.

Continued development work by this company has resulted in one of the most comprehensive ranges of non-silicone based products for lubricating, cleaning and protecting electrical and electronic components.

Eltinert contact lubricants, for

Electrolube has also developed a range of coatings designed to protect printed circuit boards. Awareness of the potential problems resulting from unreacted silicones played an important part in the formulation of these products.

Electrolube's Heat Transfer Compound is a silicone free preparation for efficient and reliable thermal coupling of electrical and electronic components to heat dissipating surfaces.

The amazing properties of silicones have become an increasingly integral part of our lives, but now it seems we must learn to live without them again in some areas. Progress . . . there's always a catch! PE

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INGENUITY UNLIMITED

A selection of readers' ideas

MONITORED OSCILLATOR

Simple resonant measurer of inductance, capacitance or frequency plus any-waveform converted to a pure sinewave or sinewave oscillator

THIS simple circuit uses the principle that an inductor and capacitor in parallel can be put in the negative feedback loop of an operational amplifier where it will act as a wavetrap at one frequency only, the resonant frequency. If a signal is fed into the amplifier at any other than the resonant frequency, there will be no gain. If positive feedback is then applied the circuit will oscillate at the resonant frequency.

By using of a chart which relates frequency, inductance and capacitance, one can find the unknown, providing two of the variables are known. The circuit provides a very simple way of measuring, for example, inductance providing a known frequency and capacitor can be used to obtain resonance. This circuit is designed for audio frequencies but R.F. could also be covered. I have not developed such a circuit.

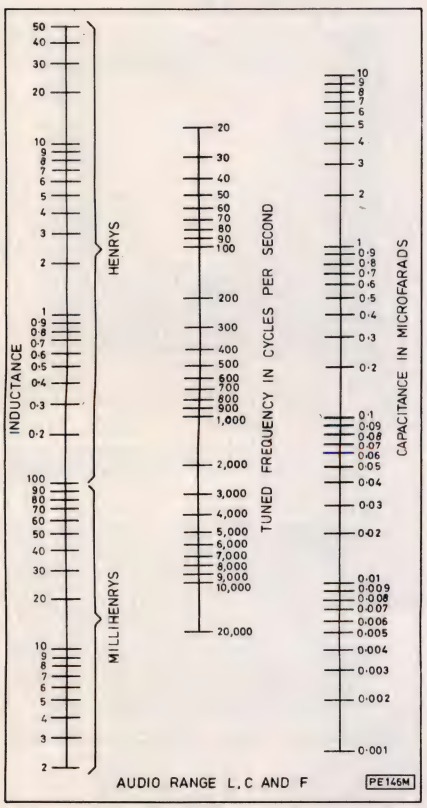


Fig. 2. *Frequencies chart*

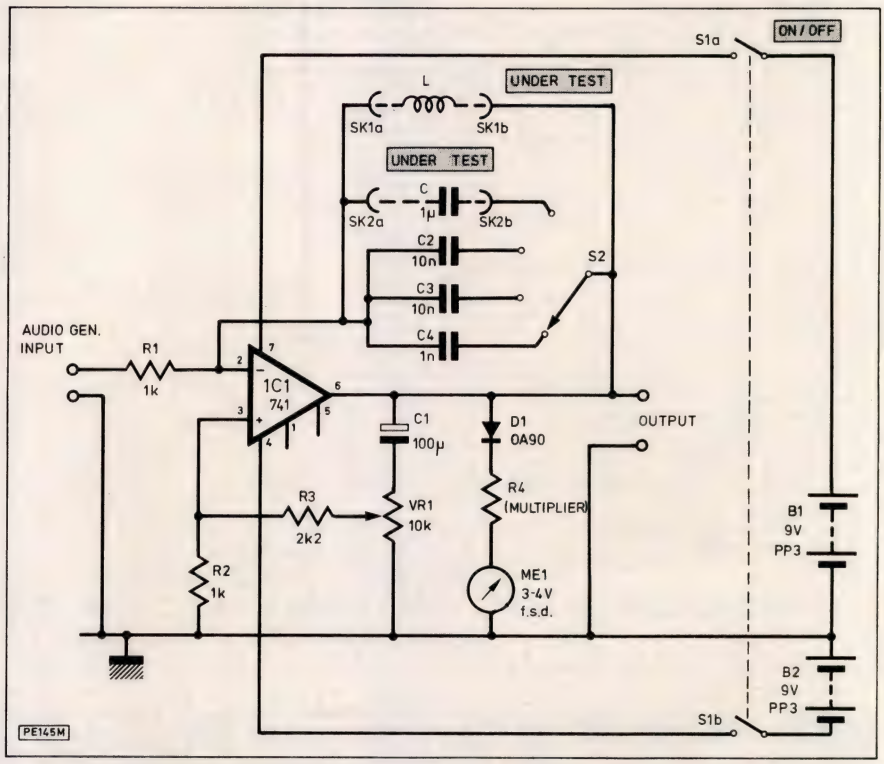


Fig. 1. *Monitored oscillator*

Fig. 2 shows the frequency chart.

To measure an unknown inductor, connect the input to an audio generator and the unknown inductor to "L under test". Use a known value of capacitance connected at "C under test". Vary the incoming frequency until a reading is given on the voltmeter whilst also varying VR1 until a sharp peak is observed at a particular frequency. VR1 must not be advanced too far or the circuit will self oscillate. To measure capacitance proceed in a similar way except that a known inductance should be connected. For frequency measurement use a known inductance and capacitance.

If an oscilloscope is connected at the output a very good sinewave will be present at resonance. This will still be so even if a square wave source is used at the input! Indeed, practically any waveform input may be used and will yield a good sinewave output at resonance. Furthermore, if the input is shorted and VR1 increased (towards C1) the circuit will go into self oscillation and produce an excellent sinewave provided the positive feedback is not too great.

The "goodness" (Q) of inductors and capacitors can be estimated by the ease with which they will go into resonance and the sharpness of tuning.

No values are shown for R4 and ME1. These form a d.c. voltmeter with D1 rectifying the output. Almost any d.c. voltmeter of around 3V to 4V f.s.d. will do. The prototype uses a 20k resistor in conjunction with a 200µA moving coil meter. The ohms-per-volt figure times 3 or 4 of the meter will give a value for R4. For example, a 50µA movement would be 20,000 ohms-per-volt, so use 60k to 80k. None of the component values are critical with the exception of any standards used for L1 or C1 or the input frequency.

The prototype was made up in a small plastics box about 150 × 75 × 50mm. This was fixed to a piece of plywood having the chart glued on. The two PP3 batteries were fitted inside and a small moving coil meter installed. This is very convenient to use. A straight-edge on the chart finds the unknown, given the other two variables. Flying leads and croc-clips are used to connect the capacitor or inductor.

B. G. J. Wallwork,
Cookridge,
Leeds.

UNUSUAL CLASS-A AMPLIFIER

High quality audio reproduction at very low cost

HAUNTING the old ghost of how to make the best possible low-cost audio amplifier, suitable for the home-constructor's, often somewhat limited, measuring and testing facilities, I came upon this idea. A quite unusual, and yet very simple circuit, performing high quality audio reproduction at a very low cost.

It consists of a long-tailed pair, TR1– TR2, plus three current mirrors. The non-inverting transistor TR2 drives the positive output transistor TR7 via TR6. Since TR6–TR7 form a current mirror with different emitter-resistor values, the current flowing through TR7 will be approximately 460 times (R3/R4) higher than the one through TR6, thus producing the current necessary for driving the speaker. The same of course goes for TR8–TR9, being driven by the inverting input transistor TR1 via the current mirror TR4–TR5.

Since no current amplification takes place in TR4–TR5, the current driving TR8–TR9 is equal to the one driving TR6–TR7, if TR1–TR2 are in balance. (The only function of TR4–TR5 is to invert the current flow from TR1 to TR8.) Thus the quiescent current through the output rail depends on the current flowing through TR1 and TR2. This can be set by adjusting VR2, since Ic TR1 + Ic TR2 = Ic TR3, and TR3 functions as a constant-current generator. This also makes the circuit less dependent on variations in supply voltage. Furthermore it provides output current limitation, since the maximum drive current from TR1–TR2, and thus the output current, will at no time exceed twice the Iq.

For adjustment, turn VR2 (starting at max. resistance) until the quiescent current through the output rail is approximately 600mA (0·24V across R4), and VR1 to set 0V at the output. Repeat until the desired condition is established, before connecting the speaker.

Note that TR6 and TR7 must be mounted close to each other at the heat-sink to prevent thermal run-away. The same of course goes for TR8–TR9. Don't forget that a class-A output stage gets hot! For TR4 and TR5 one can use any general purpose *pnp*-transistor, but make sure that it will operate at the full supply voltage. Note also, except TR3, TR4 and TR5, the rest are darlington types.

Preferably all transistor pairs should be matched, but this is not strictly necessary, except for TR4 and TR5. With component values as shown, the amplifier will deliver some 8 watts into an 8 ohm load. This of course can be increased by increasing supply voltage and quiescent current, although it should not be taken too far.

J. Moller,
Copenhagen,
Denmark.

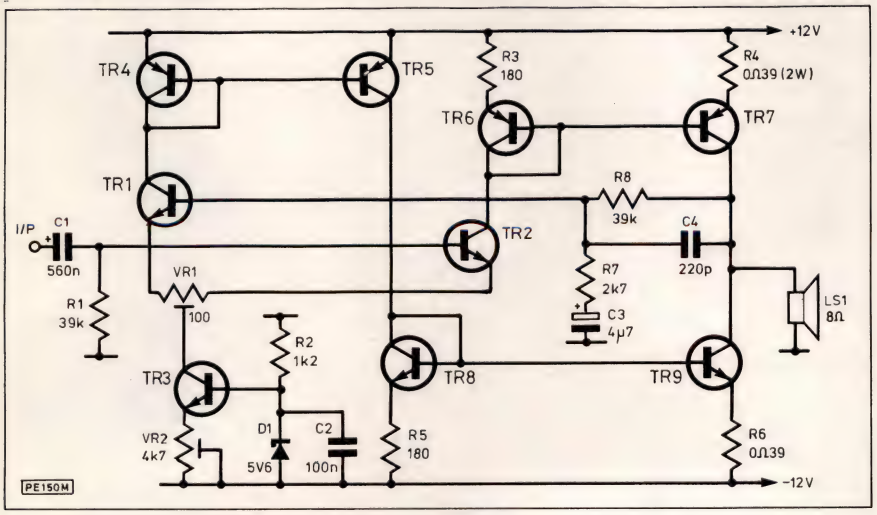


Fig. 3. *Class-A amplifier*

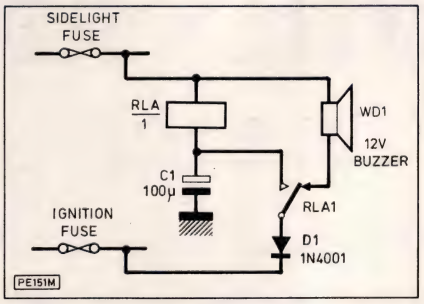


Fig. 4. *Headlight alarm*

CAR HEADLIGHT ALARM

Next winter, make sure that your car will start

THIS circuit was designed two years ago, when I suffered two flat batteries on consecutive mornings, to combat this problem. The circuit cost just over £2.00 to build and has successfully been in operation since.

The circuit takes its power from the sidelight and ignition fuses. Diode, D1 isolates the circuit when either the ignition is on or the lights are off, when a warning would not be wanted.

The circuit has two modes of operation. When the lights are switched on with the ignition on, as would be the case during normal driving, both fuses will be at +12V and so no current will flow. However, if the ignition is now switched off without the lights also being switched off, the ignition fuse will now be at earth potential and current will flow through the buzzer and give the required warning.

If the lights are required as parking lights then the relay comes into operation. If the sidelights are switched on while the ignition is off then C1 causes the relay to momentarily operate. The contacts, therefore, switch over diverting the current from the buzzer and latching the relay, thus suppressing the warning. When parking, the lights are simply switched off and back on, to halt the warning.

S. L. Jones, Pittingham, Durham.

REGULATOR +10V AND +5V

THIS circuit provides stabilised, +10V and +5V, supplies from an unstabilised input of +11V to +20V. It can be used for powering op-amp circuits from a single supply using the +5V supply as a centre reference supply.

A 7805 provides the +5V output and is used as the reference for the +10V supply. D1, a 5V6 zener diode ensures the output is 5V above the +5V supply via the amplifier transistor, TR1 and the series pass transistor TR2. Using a *pnp* series pass transistor means that the input-output differential voltage can be as low as 0·5V whilst maintaining regulation.

K. Wevill, Ratby, Leicester.

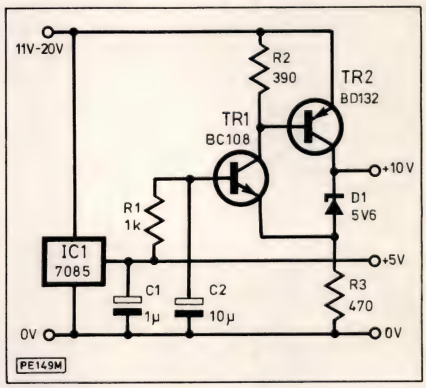


Fig. 5. *Regulator circuit*

ROBOTICS REVIEW

By NIGEL CLARK

Our regular look at robotics in education and industry

THE world of the Alfreds from Robot City Technology of Milton Keynes is expanding. As announced in *Practical Electronics* two months ago the company has developed a bigger version of the Alfred I known as Alfred II, which is now available with the first orders having been sent out.

The design is based on the meccano-like appearance of the Alfred I, it being a traditional five axis arm with gripper, powered by servos with closed loop control and driven by a toothed belt. However, the construction is far more rugged.

MODULAR CONCEPT

Alfred I at a price of about £200 and with a modular building concept is intended as an introduction to robots with the possibility of expansion later. Alfred II is selling for about £1,300 and is aimed at higher education but is also strong enough to be used in some light industrial applications.

The larger Alfred has a quoted lifting capacity of 2kg, although the makers say that it has lifted 3kg, whereas Alfred I can only lift 170gms. Its reach at 580mm is greater than the 380mm of the Alfred I, with the waist being able to move through 270 degrees, shoulder through 110 degrees, elbow 135 degrees, wrist pitch 180 degrees and roll 180 degrees. It also has an on-board Z80-based processor which can accept up to 200 steps being entered from a keyboard. In addition it can be controlled by a BBC B and Spectrum through the serial port.

The development of an on-board processor and using a serial rather than parallel port have been adapted for the Alfred I and the parallel port is being phased out.

Alfred I is breaking into the export market with the European and American markets being studied. One problem which has been encountered in some parts has been the name. Apparently in some German-speaking countries Alfred is a well-known television character who beats up his wife regularly. Robot City has decided that rather than be associated with that sort of character it preferred to change the name, so Alfred is now known as Pico in those countries.

Not so successful has been Reekie Technology with its Reekie Universal Robot, which was featured in *Practical Electronics* last year. While it has attracted interest from a large number of enthusiasts, none have so far come forward to buy one.

The company saw the RUR as the first step towards creating a low-cost device which people would accept as looking like a robot but also performed some quite complicated manoeuvres. Before its introduction the market was limited to the toys from Tomy, Omnibot, Verbot and Dingbot and for a short time the Androbot range or the much more expensive Hero 1, which was considered for the education market.

RUR, selling in kit form for about £450, is a mobile robot with a central processor control and battery-driven motor. A serial output allowed control from an outside micro. It was built so that it could be expanded with the addition of a number of add-ons such as sensors so that it could gain some idea of its environment.

However, the lack of response has meant that the development of further add-ons is a low priority at Reekie for the moment.

"It is incredible," said a spokesman. "We were warned that it might take a while for the product to get established but we did not think the reaction would be as low as this."

In the meantime the company is concentrating on its more successful lines. These include the Cepek Scara robot which was also launched last year but has been selling quite well and the mobile robot for working in hazardous environments such as fires or where there is a suspected unexploded bomb.

But the Universal has not been forgotten and if there is a sudden burst of interest, Reekie is ready to respond.

COMMOTION

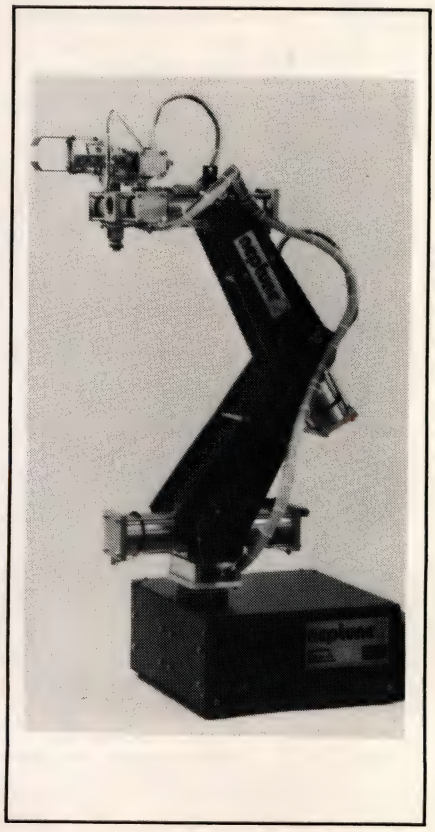
Commotion of Enfield has produced a new power supply which can cope with the extra demands for power with the increasing number of add-ons being connected together. It is intended primarily for the schools market but that does not preclude the home enthusiast from taking advantage.

Tim Coote of Commotion said that power supplies at present did not push out enough power for all the devices that were being run off them. His supply has two outputs one producing 5 volts at a rate of 1 amp and the other switchable between 6 volts and 12 volts at a rate of 4 amps. The switchable output levels are both variable by 1 volt either way.

BEASTY SERVO

Coote says that the supply, which sells from £55, is completely protected and idiot proof. All the possible incorrect connections have been considered and the device has been made so that nothing serious will happen whatever is done to it.

In response to popular demand the company has also produced a gripper for its simple Beasty arm. In its original form the 3-axis Beasty only had a hook or an electromagnet for picking



up things. Now, however, for £15 it is possible to add a two-fingered gripper.

The upgrade kit includes another Beasty servo and instructions on how to adjust the building of the arm. Because the arm is so small and light slight changes have to be made in its construction to allow for the extra weight of the servo and gripper on the forearm. The rest of the servo-driven arm, which costs in kit form about £120 and runs off the BBC B with the help of a thorough and well-written manual will be the same.

ARMS TO THE GULF

Cybernetic Applications continues to develop its range of arms and accessories. The latest addition is a measuring gauge to go with its work cell.

The gauge measures the width of objects as they pass along the work-cell's conveyor belt. The objects can then be either accepted or rejected, sorted into various sizes or statistics calculated of the different sizes. It is available now and works with Cybernetic's full range including the Neptune, Mentor, Naiad and Serpent.

The company is also expanding into new markets overseas. It is still waiting for orders to flow in from its agent in Russia but in the meantime it is selling to other exotic locations. The latest is an order for most of the company's range from a research establishment in Bagdad, Iraq. Dick Becker, managing director of Cybernetic, said that there were no problems with the order except that the arms should not be addressed to the Persian Gulf. The Iraqis prefer to call it the Arabian Gulf.

Despite the failure of the First European Personal Robotics Conference and Exhibition held last year in London it is hoped to organise a similar but more successful event this year, again somewhere in London and in July.

A number of professional bodies which have an interest in the robotics field have been approached to see if they would be interested in helping to organise the event. They include the Institute of Electronic and Electrical Engineers, the Institute of Mechanical Engineers and the British Computer Society.

The optimism that a conference could be a success in Britain is based on the growing interest being seen in robotics particularly in education and the experience of the two personal robotics conferences in the States in the last two years, first in Albuquerque and last year in San Franscisco, which attracted a number of visitors from Europe. PE

CURRENT AND VOLTAGE MONITOR

Provide cost effective p.s.u. monitoring with a d.p.m. and a minimum of components

THIS circuit was designed to enable a digital panel meter (d.p.m.) to monitor the output current and voltage of a variable power supply with the minimum of switching.

IC1, a 741 op-amp is configured as a differential amplifier which gives an output proportional to the voltage drop across the series pass regulator transistor emitter resistors and is independent of the p.s.u. output voltage. The gain of the amplifier is approximately $\frac{1}{8}$. This is to ensure that the voltage at the non-inverting input of IC1 does not exceed the op-amp +Ve supply. The values given enable the circuit to work with p.s.u. output voltages up to 6 times the op-amp +Ve supply voltage. IC2 amplifies the output up to the level required by the d.p.m., typically 0 to 2V.

Fig. 2 shows the connections to the d.p.m. to enable the p.s.u. output voltage and current to be monitored.

The op-amp power supplies can be derived from the d.p.m. or a separate +Ve regulator and negative voltage converter such as the 7660 fed from the unregulated input. The set zero control should be adjusted for a reading of zero with no load on the p.s.u. Adjust the set full scale for a reading equivalent to the load current.

K. Wevill,
Ratby,
Leicester.

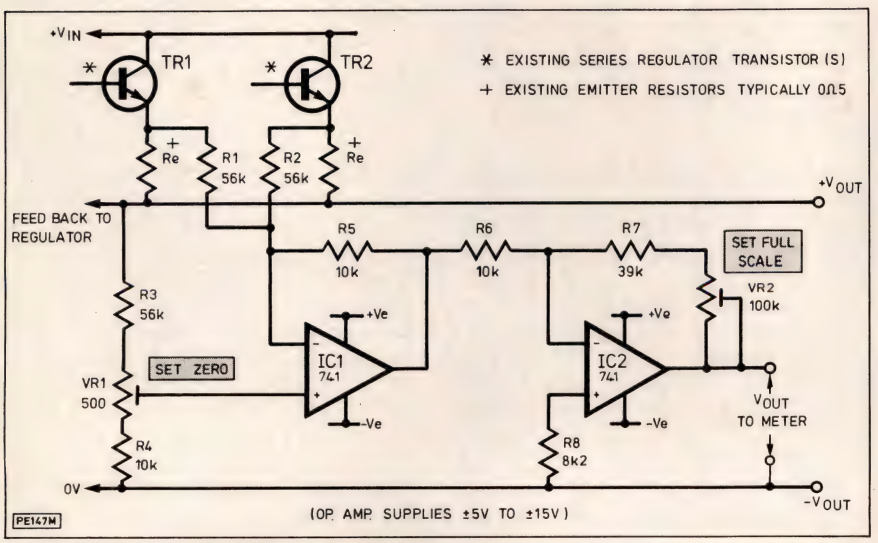


Fig. 1. *Complete circuit diagram*

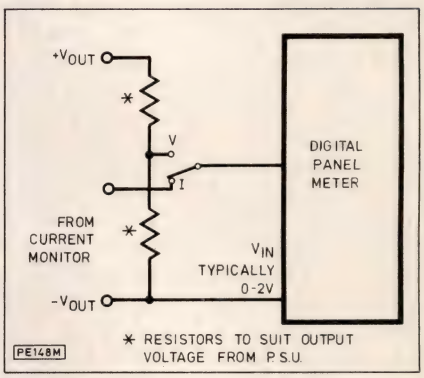


Fig. 2. *D.p.m. connections*

INDUSTRY NOTEBOOK

BY NEXUS

What's happening in the electronics world—and down in the sewers

STC ALL SET FOR RECOVERY

Standard Telephone & Cables is beginning to get back on its feet financially after a disastrous 1985. In August last year it reported a first-half net loss of £8·7 million—compared with a profit of £44·4 million in the previous year. The share price plunged, to put the company among the worst performers on the stock market. In the same year the then chairman, Sir Kenneth Corfield, resigned.

Rescue action, however, was very prompt. By September the company had brought in a new chief executive, Arthur Walsh, who came from Marconi (GEC). He immediately started a major cost-cutting exercise, aimed at restoring confidence in the financial world. Inevitably, heads rolled, both in the board of directors and at lower levels. Following the GEC formula, authority for making important decisions has been decentralised and now the managers of individual plants within STC have much more autonomy.

Bureaucracy at head office has been severely pruned and the company is moving out of its plush h.q. in the Strand, London—at which I confess to having enjoyed several unnecessarily lavish meals in the course of duty. (Message to the board: I'll be quite happy with a cup of tea and a biscuit in the future.)

On the electronic components side alone, the new board of directors has removed about 150 people and reorganised the management of the company concerned, STC Components Ltd. More jobs will be lost when this part of the group closes its tantalum capacitor plant at Aycliffe, Co. Durham, early this year.

One of the new STC directors is actually an old hand in the electronics industry: Sir Raymond Brown. At the beginning of his long career, as plain Mr Brown, he worked for Redifon on radio communication equipment and for Plessey. In 1950 he was one of the two founders of Racal. (The 'Ra' in the company's name comes from Raymond.) In later years Brown became widely known through his Ministry of Defence job as a kind of super-salesman for exporting British-made military equipment. More recently he returned to the electronics industry as chairman of Muirhead.

A DOUBLE LIFE

What seems extraordinary to plain folk like electronics engineers is that a company such as STC can go through such violent financial and management upheavals while still performing a perfectly stable and successful role in engineering and manufacturing. STC is an old-established, highly respected company which continues to get substantial orders from important customers. Just recently, for example, it has won a £50 million order from British Telecom for exchange equipment, a £4 million one from the USA for optical fibre cables, and a £1 million order from China for optical transmission equipment. Last year STC bought ICL (International Computers Limited) and thus added computers and data transmission to telecommunications to become a full-blown information technology group.

It's a paradox of the business world that product development, manufacturing and sales can carry on quite successfully while, at the same time, the management of the people, resources and finance can go badly wrong. There must be some structural weakness in systems that allow this dissociation to occur.

BRITAIN'S COMPUTER PAST

A recent trip to the Science Museum, South Kensington, served to remind me how ICL, now part of STC, actually came into being. I went to see the remains of the pilot model of the ACE (Automatic Calculating Engine) developed by the National Physical Laboratory during the 1950s. This research machine was eventually used as the basis of a commercial product, English Electric's DEUCE computer. Similarly Manchester University's pioneering work on digital computers was put into commercial form as the Ferranti Mark 1.

In those early days there were, on the one hand, university, industrial and government research laboratories who understood and constructed digital computers and, on the other hand, business equipment manufacturers who couldn't understand or develop computers but knew a lot about business data processing as it was then practised. Inevitably, the two sides got together. In addition to the two partnerships mentioned above, British Tabulating Machine Co. teamed up with GEC, Powers Samas with Ferranti, and National Cash Register with Elliot. Later, Lyons Electronic Office (LEO) joined forces with English Electric to form English Electric Leo Computers.

Then the massive competition from IBM and other American computer giants became too much for these individual UK partnerships and eventually they all came together for protection in the form of International Computers and Tabulators (ICT). This was the forerunner of ICL, which therefore became virtually the repository of the British main-frame computer business.

MILITARY ELECTRONICS

A gremlin in the February issue of PE made my comments under 'If peace breaks out' end rather mysteriously with Groucho Marx, the real end-piece being lost.

Having said that the UK electronics industry is heavily dependent on military electronics business and particularly on Ministry of Defence spending, I started to suggest that the possibility of an end to East-West tension and a consequent cessation of the arms race would bring about considerable changes. My conclusion, accidentally deleted, was that if the electronics industry really sees a viable future for its customer *Homo sapiens* it should be considering what to do in the absence of a fear-induced market for military equipment. Those apologists who try to justify military R&D effort by pointing to the benefits of peaceful spin-offs should start considering these spin-offs as primary developments and products. If these products are really so beneficial to us they should be worth making and selling in their own right.

ELECTRONICS DOWN THE TUBE

Every time you flush the toilet or pull the plug out of the bath or kitchen sink I don't suppose you give a moments thought to how the domestic effluents are safely and swiftly carried away from your household. And you may now ask what this has to do with electronics.

Well, there is in fact a small but growing sector of the UK electronics industry which is deeply concerned with this process. It consists of about half a dozen small companies who make closed-circuit television equipment specially designed for the mucky business of inspecting sewers—mainly the pipes which are too narrow to be entered by human inspectors. Two such firms are Telespec Ltd and Rees Instruments Ltd, both from near Woking, Surrey.

The basic reason for the emergence of this TV inspection technique is that Britain's sewers are crumbling. Many were built over a hundred years ago in response to the concentration of population in towns following the Industrial Revolution. They did much more for public health than medical science could manage and largely got rid of cholera epidemics in London and other cities. But the old sewer pipes are now disintegrating at an alarming rate. Local and water authorities are busy on an almost permanent programme of repair.

To dig up old pipes laid under busy thoroughfares and buildings would cause far too much disruption, socially and economically, so many of these pipes are being re-lined with plastics materials, working from a manhole at one end. This is where the special immersion-proof CCTV equipment comes in. It is used first to inspect the initial state of the pipes and record the nature and position of the damage. Then it is used to observe and control the operation of remotely controlled water-jet cutting machines which travel along the pipes and clear away all kinds of obstructions to the re-lining process. Finally, after re-lining, the TV equipment is used again for a final inspection of the work.

LARGE PROPORTION

A large proportion of the output of these small firms is exported for use in similar sewer repair work abroad. What happened in Britain during the 19th century also happened a little later in the rest of the industrialized world. The steady disintegration of old sewer pipes throughout North America, Europe and all countries which are now industrializing and attracting people into large conurbations should provide plenty of future business for this little-known sector of the UK electronics industry if it manages to stay competitive on price and delivery.

PHILOLOGICAL FOOTNOTE

Nexus is my name, and my nature is to connect. Of course, this pseudonym refers both to the fact that I join with you in communication and the fact that electrical connection is at the very heart of the electronics business.

Also appropriate, perhaps, is the somewhat derogatory phrase 'the cash nexus'—meaning that many human relationships are based not on purely human values like the concept of duty but exist only through money transactions. Thomas Carlyle, the 19th-century historian and philosopher, probably originated the phrase in his essay on Chartism. He refers to "epochs when cash payment has become the sole nexus of man to man." I wonder if EFT (electronic funds transfer) would have made any difference to the old curmudgeon's distaste. PE

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350	24.64	2.94
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1000	55.65	4.20
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3000	121.12	O/A
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250	19.92	2.77
350	24.64	2.94
500	30.69	3.10
1000	55.65	4.20
2000	86.38	6.46
3000	121.14	O/A
6000	240.19	O/A

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1	.5	3.35	1.38
2	1	4.46	1.48
4	2	5.15	1.69
6	3	8.07	1.76
8	4	9.43	1.84
10	5	10.31	1.90
12	6	11.43	1.99
16	8	13.62	2.33
20	10	18.33	2.58
30	15	22.79	2.78
40	20	32.52	3.08
60	30	46.69	4.68
83	41	53.76	4.95

96/48V. Pri. 2×120V Secs. 2×36/48V

96/72	48/36	Price	P&P
0.5	1	5.64	1.27
2	4	15.42	2.31
3	6	18.68	2.52
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6	12	42.38	3.68
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4	8	14.80	2.28
6	12	18.91	2.39
8	16	26.75	2.90
10	20	31.74	3.29
12	24	37.99	3.46

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2	4	9.66	2.00
3	6	13.96	2.20
4	8	15.91	2.31
5	10	20.11	2.48
6	12	22.95	2.78
8	16	32.26	3.20
10	20	37.55	3.50
12	24	43.28	3.95

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3-0-3V	.2	3.26	.96
6×2	1A×2	3.62	1.30
9-0-9	.1	2.72	.96
9×2	0.33×2	2.53	.96
8-9×2	.5×2	3.53	1.30
8-9×2	1A×2	4.48	.96
15×2	.2A×2	2.53	.96
12-0-12	.05	3.21	.96
20×2	.3×2	3.55	1.30
20-12	.9	4.34	1.70
15-20×2	1A×2	5.88	1.70
15-27×2	.5A×2	5.07	1.50
15-27×2	1A×2	7.66	1.74
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0-CT-15V	4A	7.28	1.40

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1	2	4.54	1.48
2	4	7.34	1.69
3	6	8.50	1.95
4	8	10.15	1.99
5	10	12.55	2.10
6	12	14.20	2.30
8	16	19.00	2.26
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4028	29p	74LS133	34p	2732	280p	HA-1197	150p
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4035	45p	74LS151	32p	6502	300p	HA-1377	220p
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4038	48p	74LS155	41p	6809	600p	HA-1397	250p
4039	190p	74LS156	47p	6821	140p	HA-1398	240p
4040	36p	74LS157	30p	6840	310p	LA-1201	85p
4041	38p	74LS158	33p	6850	110p	LA-1352	120p
4042	30p	74LS160	48p	8080A	400p	LA-1365	140p
4043	36p	74LS161	50p	8085A	320p	LA-3301	120p
4044	38p	74LS162	48p	8155	390p	LA-3350	120p
4045	72p	74LS163	48p	8156	360p	LA-3361	115p
4046	45p	74LS164	43p	8224	270p	LA-4030	200p
4047	45p	74LS165	65p	8226	270p	LA-4031	140p
4048	27p	74LS166	74p	8228	270p	LA-4032	140p
4049	18p	74LS168	92p	8243	250p	LA-4050	130p
4050	20p	74LS169	65p	8250	850p	LA-4051	160p
4051	36p	74LS170	80p	8251	300p	LA-4100	120p
4052	37p	74LS174	39p	8253	340p	LA-4101	100p
4053	37p	74LS175	42p	8255	360p	LA-4102SK	140p
4054	53p	74LS190	55p	8256A	1200p	LA-4112	250p
4055	52p	74LS191	52p	8257A	370p	LA-4125	210p
4056	52p	74LS192	50p	8259	370p	LA-4140	70p
4060	40p	74LS193	51p	8271	4400p	LA-4201	120p
4063	52p	74LS194	53p	8272	1300p	LA-4220	120p
4066	20p	74LS195	52p	8279	650p	LA-4400	190p
4067	130p	74LS196	62p	8282	400p	LA-4420	140p
4068	13p	74LS197	52p	8283	400p	LA-4422	130p
4069	13p	74LS221	56p	8284	500p	LA-4430	130p
4070	13p	74LS240	55p	8288	1000p	LA-4460	170p
4071	13p	74LS241	55p	8748	2900p	LA-4461	180p
4072	13p	74LS242	55p	SP0256AL2	500p	LA-5112	120p
4073	13p	74LS243	60p	Z80ACPU	180p		
4075	13p	74LS244	50p	Z80ACPU	600p		
4076	45p	74LS245	50p	Z80BCPU	600p		
4077	13p	74LS247	50p	Z80ADMA	650p		
4078	13p	74LS248	50p	Z80AP10	250p		
4081	13p	74LS249	50p	Z80BP10	600p		
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4085	40p	74LS253	50p				
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AN-7115	160p	LM348	60p
AN-7120	140p	LM380	100p
AY3-1270	680p	LM381	150p
AY3-1350	300p	LM382	130p
AY3-8910	360p	LM387	100p
AY3-8912	400p	LM709 DIL	30p
AY5-3600	570p	LM723	40p
CA270	40p	LM741 DIL	18p
CA3046	60p	LM741 MET	45p
CA3048	190p	LM747	80p
CA3060	240p	LM748	35p
CA3080E	70p	LM1458	33p
CA3086	55p	LM3900	30p
CA3089E	150p	M-51513L	180p
CA3090AQ	300p	M-51515BL	270p
CA3130E	80p	M-51516	280p
CA3130S	100p	M-51517L	280p
CA3140E	38p	MB3712	150p
CA3189E	250p	MB3730	260p
CA3240E	90p	MB3756	260p
HA-1156W	110p	MC1327	70p
HA-1197	150p	NE555	20p
HA-1306W	170p	NE556	40p
HA-1319	250p	SAS560	110p
HA-1339	170p	SAS570	110p
HA-1342	170p	SN76003N	140p
HA-1366WR	160p	SN76110N	70p
HA-1388	160p	SN76115	70p
HA-1377	220p	TZ8000	52p
HA-1389	140p	TA-7120	55p
HA-1392	230p	TA-7137P	83p
HA-1397	250p	TA-7146P	400p
HA-1398	240p	TA-7193P	400p
LA-1201	85p	TA-7200	200p
LA-1352	120p	TA-7201	200p
LA-1365	140p	TA-7203	180p
LA-3301	120p	TA-7204	110p
LA-3350	120p	TA-7205	80p
LA-3361	115p	TA-7210	200p
LA-4030	200p	TA-7222AP	120p
LA-4031	140p	TA-7310P	100p
LA-4032	140p	TA-7609	270p
LA-4050	130p	TAA550	16p
LA-4051	160p	TBA120S	45p
LA-4100	120p	TBA395	60p
LA-4101	100p	TBA398	80p
LA-4102SK	140p	TBA520	100p
LA-4112	250p	TBA530	100p
LA-4125	210p	TBA540	100p
LA-4140	70p	TBA560	100p
LA-4201	120p	TBA750	100p
LA-4220	120p	TBA800	35p
LA-4400	190p	TBA810S	80p
LA-4420	140p	TBA820	75p
LA-4422	130p	TBA920	100p
LA-4430	130p	TBA950	100p
LA-4460	170p	TBA990	100p
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SCRATCH AND RUMBLE FILTER UNIT

BY D. STONE

Audio enhancement unit for stereo hi-fi systems —featuring switchable filtering

When making audio tape recordings, noise on the tape can become annoying. This noise can take two forms, the first is high frequency 'hiss', and the second is low frequency 'rumblings'. The high frequency hiss can be caused by the tape medium and/or the amplifier. The low frequency noise is less noticeable and it is generally caused by the record or the record deck.

To try to combat the problem of noise, the audio enhancement unit consists of stereo scratch (high frequency reject) and rumble (low frequency reject) filters. These filters have switched frequency responses in order

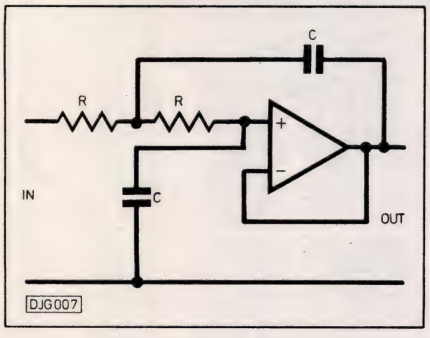

Fig. 2. *Second-order filter*

to control the filter for the correct degree of band reject. The scratch filter has switchable cut-off frequencies of 13kHz, 8kHz and 3·5kHz. All frequencies below these are passed unaffected by the scratch filter, all frequencies above the cut-off frequencies are attenuated by 12dB per octave in each channel.

The rumble filter cut-off frequencies are 30Hz, 60Hz and 110Hz. This filter will pass any signals unaltered if they are above the cut-off frequencies and attenuate signals with 12dB per octave below these frequencies. The rumble filter in the 60Hz and 110Hz positions will remove any mains hum from the signal. The 110Hz position will also remove power hum if it is due to rectified mains, i.e. caused by the power supply.

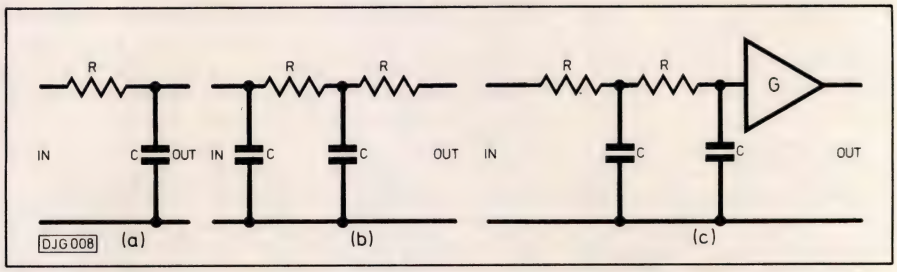

Fig. 1. *Filter variations*

CIRCUIT DESCRIPTION

The project is based around two identical halves, one for each of the two channels. Each channel is made up from a low pass filter followed by a high pass filter. Switches are provided to bypass the filters if required.

The filters are second order Sallen & Key configuration filters. The standard first order filter for a low pass system is shown in Fig. 1a. This filter has a corner frequency of $2\pi CR$. The Roll-off is 6dB/octave. In this circuit, the capacitor is an open circuit at d.c. and doesn't influence the circuit much at low frequencies. In effect it is similar to just putting a resistor into a low frequency line. As the frequency increases, the capacitor conducts more and more. This increased conduction tends to short the high frequencies to the signal earth point.

If two of these networks are put in series, a second order filter is produced. The corner frequency is the same, but the roll-off is now twice the above figure, i.e. 12dB/octave. This configuration is shown in Fig. 1b.

Unfortunately, at low frequencies, even though the capacitor has negligible effect on the signal, the resistors do weaken it. To overcome the effect of the resistors, an operational ampli-

COMPONENTS . . .

RESISTORS

R1, R6, R101, R106	27k (4 off)
R2, R5, R8, R11, R102, R105, R108, R111	12k (8 off)
R3, R4, R103, R104	15k (4 off)
R7, R10, R107, R110	18k (4 off)
R9, R12, R109, R112	39k (4 off)
R13, R14	4k7 (2 off)
All ¼W 5%	

CAPACITORS

C1, C6, C101, C106	10µ 16V (4 off)
C2, C3, C102, C103	100n (4 off)
C4, C5, C104, C105	680p (4 off)
C7, C8	220µ 10V (2 off)

SEMICONDUCTORS

IC1, IC2, IC101, IC102	CA3140 (4 off)

MISCELLANEOUS

S1, S3	4-pole, 3-way rotary switch (2 off)
S2, S4	1-pole change-over switch (2 off)
S5	on/off switch

I.c. sockets; I/O sockets; wire; case; battery & clip (PP6); p.c.b.; PE 106, etc.

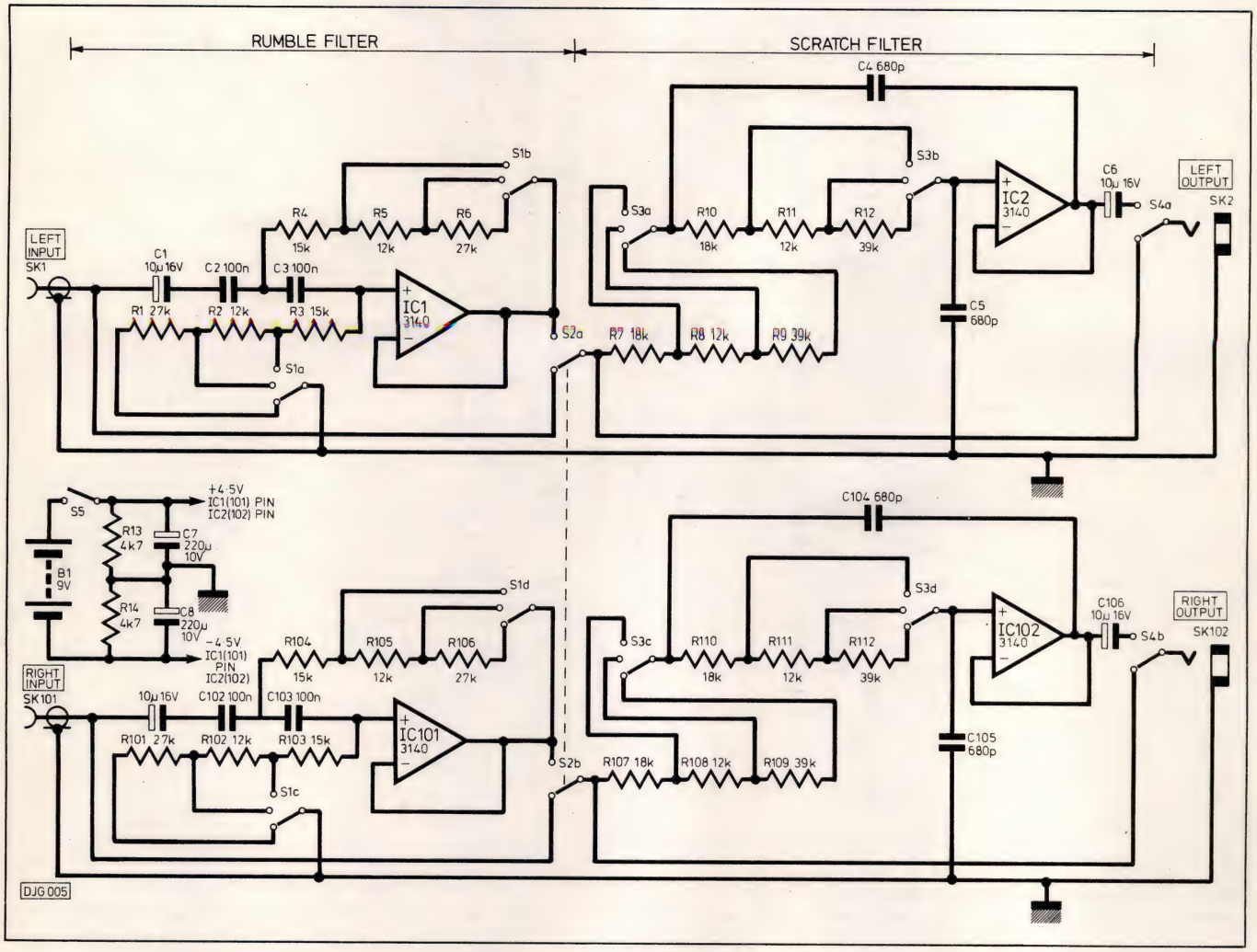

Fig. 3. *Complete circuit diagram*

fier is used to boost the signal back to its original level. A schematic diagram is shown in Fig. 1c. This provides a system which doesn't alter the signal below the cut-off (or corner) frequency, and attenuates the signal at 12dB/octave after it. The gain of the op-amp should be set to just cancel the effect of the resistive signal drop.

A complete circuit diagram of the unit is shown in Fig. 3. To set this gain, external components are needed around the op-amp. These extra components can be removed if the op-amp is set up as a voltage follower and the grounded end of the first filter capacitor connected to the op-amp output instead. This is the standard second order Sallen & Key circuit shown in Fig. 2.

The variable corner frequencies are found by varying the values of the resistors together. This was achieved with 4-pole, 3-way switches. A split rail supply was derived from a 9V battery with R13 and R14. This supply rail (signal earth) was decoupled with C7 and C8.

CONSTRUCTION

Construction of the project is fairly simple if it is done with some degree of care. There is a moderate amount of interwiring to be carried out, this is due to the great versatility of the project.

The p.c.b. should be constructed in the usual method, wire links first followed by resistors, i.c. sockets, Vero pins and capacitors. When wiring the project, it is advisable to use screened leads for the inputs to the board.

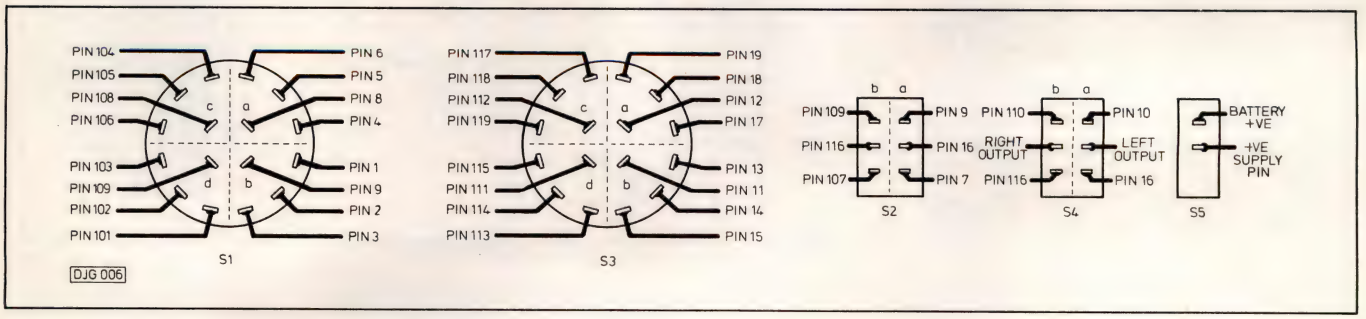

Fig. 4. *Switch wiring details*

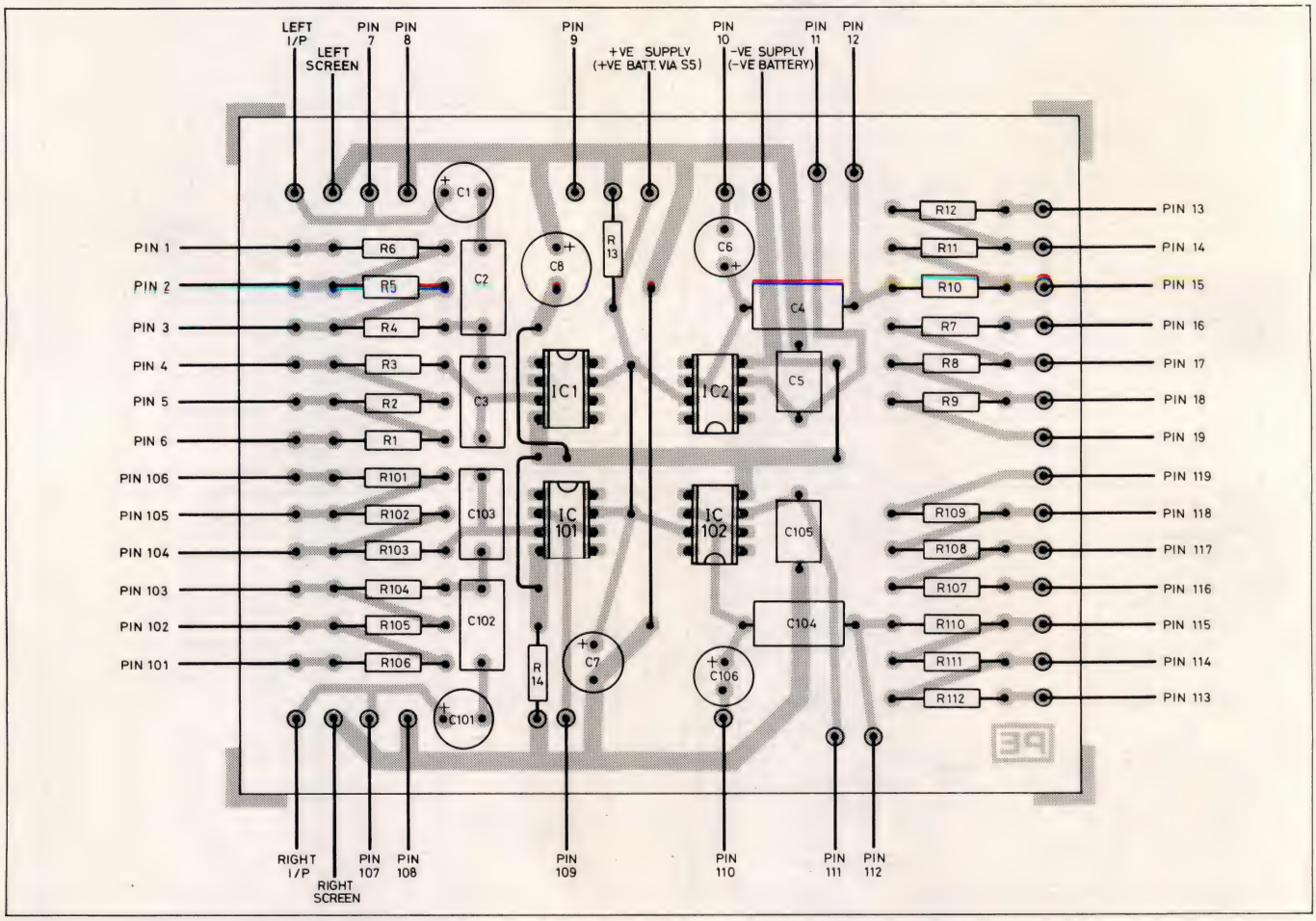

Fig. 5. *P.c.b. design and component layout*

Both left and right channels have been put on the same board for simplicity. The components for the right channel are all numbered upwards from 100. R1 in the left channel is duplicated in the right channel by R101.

The output sockets should be chosen to suit the equipment which the unit is to be used with. The prototype used DIN sockets. The unit can either be fitted into a plastic or a metal case, the prototype being housed in a plastic case.

IN USE

If the circuit is wired correctly, there is no setting up required. As there is a fair amount of wiring, a moderate amount of care should be taken with it. The wiring is not difficult, maybe just a little tedious.

In use, the cut-off frequencies should be set to give the best sound according to your taste. The prototype was used between a pair of tape decks in a Hi-Fi system. The power for the prototype was provided by a PP6 battery. If a mains supply is being considered, care should be taken to ensure that mains hum does not find its way onto the power supply rails due to insufficient power supply decoupling. PE

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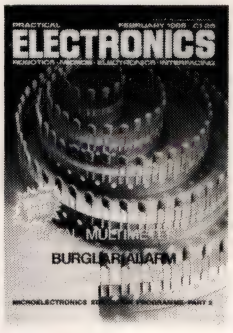

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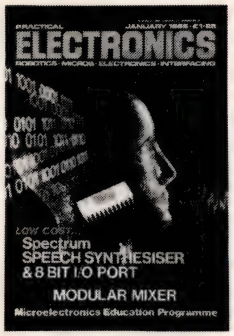

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Late News:

This page features a collection of last minute news and press releases received immediately prior to the magazine going to press. Many of the items mentioned on this page will be discussed in greater detail next month.

Multiprocessor systems are made easy with the Hitachi HD63310 smart RAM chip. This chip allows a 1K x 8 memory area to be shared between two microprocessors, each with their own bus access. The chip design incorporates enough inteligence to overcome any potential memory access conflicts.

New super graphics display chips from Texas have just been launched. These chips include the TMS34010, TMS34061 and TMS34070. The TMS34010 graphics system processor is a 32-bit device. The TMS34061 a high resolution video systems controller, and the TMS34070 is a colour palette chip capable of generating up to 4096 colours per frame. This family of chips is capable of generating very high resolution colour graphics displays at great speed.

A new family of very low cost (about £30) mini printers has been launched by Epson. These small dot matrix printers can print up to 42 columns of text or 252 dots per line on 57.5mm plain paper. Their small size, low power consumption and easy interfacing make them ideal for incorporation into portable equipment.

Single chip microcomputers are becoming increasingly versatile and powerful. An example is the new ZTAT range from Hitachi. These devices offer up to 16K bytes of EPROM and 256 bytes of RAM plus a wide range of I/O on a single chip. Probably the most powerfull of the range is the HD63705 with 8K EPROM 348 bytes RAM 68 I/O lines, 5 timers, asynchronous/synchronous serial communications port and an 8-channel 8-bit A/D converter. All EPROMS in this series are easly programmable.

An increased use of Programmable Logic Devices can be expected from the launch by Intel of a new family of Erasable Programmable Logic Devices. These chips use the same technology as EPROMs to allow the designer to rapidly construct custom logic circuits incorporating up to 1200 gates. This makes testing of such devices much easier and far less costly. The 5C060,5C090 and 5C121 offer some exciting opertunities to circuit designers wishing to use PLDs.

Toshiba have anounced the development of an eight colour, active matrix, 640x480 pixels, 10 inch diagonal l.c.d It is backlit and has a brightness nearly equal to that of a colour TV.

The development of Gallium-Arsenide integrated circuits is beginning to gather pace. These very high speed devices are capable of operating at frequencies of up to 1 Gigaherts. Two US companies GigaBit Logic and Vitesse have both announced production of 1000 gate devices and expect to have LSI devices (including microprocessors) in production by late 1987.

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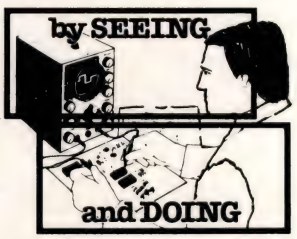

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EMI MEANS TROUBLE

BY SIMON BATTMAN

The navigation system suddenly flips out of control. Searching frantically for a cause, the pilot pushes every button in sight, but to no avail. Then, almost as quickly as it came, the interference disappears, leaving the crew to wonder what on earth happened.

A potentially disastrous scenario such as this, could in theory be caused by nothing more than a passenger innocently operating a portable computer. Hence, some airlines, notably American, now ban all in-flight computing by their customers.

The culprit is electromagnetic interference (EMI), which is produced whenever electricity flows. You can demonstrate this for yourself by pressing the buttons on a pocket calculator held close to a radio tuned to long-wave. If you're lucky you should hear short clicks precipitated by EMI generated by the calculator.

EMI from police radios has been blamed for breath-test machines displaying false readings. TV cameras covering one space shuttle mission apparently caused vital data transmissions to become garbled and, thus lost. Most railway tracks have miles of power cables running parallel to them. EMI produced by these has caused 'stop' signals to be changed to 'go.'

Some experts believe the number of EMI generating machines—satellite ground stations, microwave relays, power lines, computers—and their increasing close proximity to each other is culminating in a 50–60 per cent annual growth of recorded interference.

Computers are not solely responsible, but merely the latest addition to the EMI club. In fact computers can be jinxed by interference as well, leading to temporary malfunctions or even total loss of memory. Home computers have been shown to produce signals as powerful as amateur radio transmitters or CB sets. In America it was recently estimated that some one million homes may be troubled by squawking stereo's and snowy TV pictures, courtesy of EMI.

INDUSTRIAL PROBLEMS

The large increase of computer controlled equipment in industry has provided yet another opportunity for EMI to cause trouble. Industrial robots appear to be particularly prone to interference, not only from other apparatus, but also from fellow robots.

If you own one of the latest high-tech cars, you may experience problems when you're driving in areas populated by large numbers of EMI generating devices. The car's computer receives data from sensors strategically located at points throughout the vehicle. If these signals are disrupted, it could lead to a reduction in engine efficiency and, therefore poor fuel economy.

SHIELDING YOUR SECRETS

Electromagnetic interference is a relatively simple phenomenon to measure, but immensely difficult to cure. At present the only really effective method is for manufacturers or users to shield their equipment. This is expensive and impractical for most situations. For instance, the price of home micros would rocket to a point beyond most people's financial capacity.

In the United States, the Federal Communications Commission (FCC) changed its rules at the end of 1983, calling for more machines to be shielded. This was marvellous news for an increasing number of companies who manufacture specialized shielding materials, but for many others, it became a financial nightmare. Coleco, makers of the Adam personal computer had to delay its introduction, and consequently lost a great deal of money. All thanks to a rather premature decision by the FCC.

For most purposes shielding isn't really needed, particularly when set against the high cost to achieve such protection. However, for some organizations this view may be rather short sighted, if one considers another characteristic of EMI.

Whenever data is displayed on a VDU or sent along cables to printers and other peripherals, the electromagnetic energy radiated will broadcast all this information to the outside world. Anyone with suitable equipment can read a standard unshielded VDU from up to five miles away. What's more, a 'hacker of the airwaves' doesn't need to know the passwords and security codes to gain access.

At one time it was believed, at least in British circles, that few outside governments knew how to accomplish such feats. This fallacy was blown a few months ago, when BBC's Tomorrow's World program demonstrated before viewing millions how easy it is to hack a computer this way. Admittedly their equipment gave a poor image, but nevertheless it was readable and it only cost £100. Given the plans, any competent enthusiast would be able to construct such apparatus with comparative ease.

Government departments have known about EMI hacking for a very long time, consequently all their computers are properly protected. On the other hand, sensitive businesses like banks, have been relatively slow to respond, leading some security consultants to declare they are just ripe for picking. It may be that they have already been picked. PE

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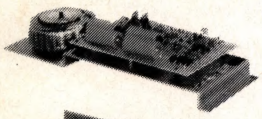

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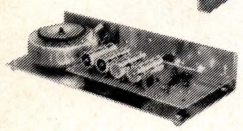

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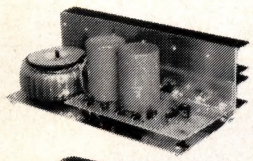

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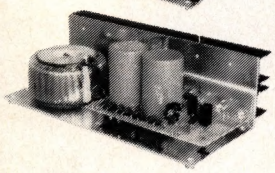

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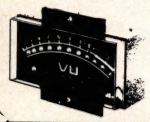

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20 oz. magnet. 1½" ally voice coil. Ground ally fixing escutcheon. Res. Freq. 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £10.99 Available with black grille £11.99 P&P £1.50 ea.

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12" 85 WATT R.M.S. C1285GP Lead guitar/keyboard/Disco.
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Res. Freq. 45Hz. Freq. Resp. to 14KHz. PRICE £29.80 + £3.00 P&P ea.

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3" ally voice coil. Die-cast chassis. Res. Freq. 40Hz. Freq. Resp. to 4KHz. PRICE £54.99 + £4.00 P&P ea.

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2" voice coil. Res. Freq. 75Hz. Freq. Resp. to 7.5KHz. Sens. 99dB. PRICE £19.15 + £2.00 P&P.

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12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
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1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £10.99 + £1.50 P&P ea.

8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1¼" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £12.99 + £1.50 P&P ea.

10" 60 WATT R.M.S. Hi-Fi/Disco etc.
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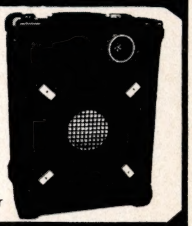

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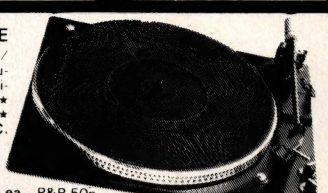

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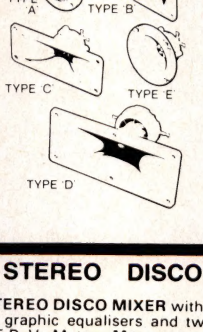

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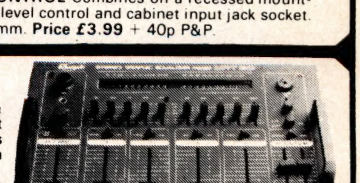

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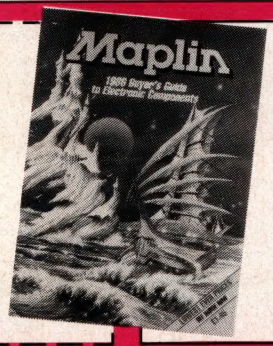

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